JPRS-JST-95-030
28 April 1995

JPRS Report

Science & Technology

Japan

Science & Technology
Japan

JPRS-JST-95-030 28 April 1995

CONTENTS

TELECOMMUNICATIONS

DEFENSE INDUSTRIES

Applying Mechanical Properties of Diamond Film

95FE0382A Tokyo SHINKU in Japanese
No. 37, July 94 pp 42-47

[FBIS Translated Text]

1. Introduction

Diamond is known to be the hardest among existing materials and has been used in industrial applications such as grindstone and abrasive grains. In addition to naturally produced diamond mineral, diamond has been manufactured by the synthetic method of transforming graphite into diamond at high temperatures, over 1,400°C, and high pressures, over 55,000 atmospheres. Synthesized diamond takes the shape of powder or particles and therefore has had limited application.

Diamond has various superior characteristics in addition to its great hardness. Table 1 shows the properties of diamond compared with those of graphite. The tensile and compressive strengths of diamond are superior to those of graphite. The elastic modulus (Young's modulus) of diamond is very high and diamond has great rigidity. Diamond is an electrically good insulator and thermally good conductor. The thermal conductivity of diamond is a few times higher than that of thermally good metal conductors such as Cu and Al and it is the premium feature of diamond. Also diamond is stable with chemicals such as acids and alkalis and has superior corrosion resistance. The only shortcoming of diamond is its poor oxidation resistance and that it burns above 700°C in air.

Table 1. Property Comparison of Graphite and Diamond

Properties	Graphite	Diamond
Crystal Structure	Hexagonal	Cubic
Density	2.10 g/cm^3	3.51 g/cm^3
Tensile Strength	75 kg/mm^2	400-100 kg/mm^2
Compressive Strength	350 kg/mm^2	887 kg/mm^2
Elastic Modulus	1,000 kg/mm^2	118,000 kg/mm^2
Thermal Conductivity	4.6 watts/cm°C	20 watts/cm°C
Coefficient of Thermal Expansion	20x10^{-6}/°C	2.5x10^{-6}/°C
Vickers Hardness	327 kg/mm^2	10,000 kg/mm^2
Resistivity	0.2-0.4Ωcm	10^{13}Ωcm
Oxidation Resistance	Burn at 500-600°C	Burn above 700°C
Chemical Resistance	Stable with Acids and Alkalis	Stable with Acids and Alkalis

Because diamond has a number of superior properties as mentioned above, the wide ranging applications using its mechanical and electric characteristics would be possible if diamond films were produced. Research in this area started in the 1950s[1)2)] and amorphous hard carbon films (diamond-like carbon DLC) was developed with the technology using ion beams in the 1970s.[3)4)] In 1981, a Soviet group published a report that it is possible to produce crystalline diamond on the surface of foreign (metal) substrates.[5)] No details of the method but key points on the synthesis were described: a certain range of high temperatures (over 500°C and below 1000°C) and the existence of nascent hydrogen, namely atomic hydrogen, are required. Obtaining hints from this paper, Matsumoto et al. at the National Institute for Research in Inorganic Materials of the Science and Technology Agency developed a chemical vapor deposition method using a hot filament for producing nascent hydrogen, and succeeded in the synthesis of crystalline diamond on foreign substrates including Si and Mo.[6)] Thereafter the microwave plasma method,[7)] high-frequency plasma method,[8)] and combustion flame method[9)] were successively developed and the growth of diamond films was realized.

Applications of mechanical properties of diamond films as well as associated problems and future potential are described in this paper.

2. Applications of Wear Resistance

Diamond-coated tools and brazed tools are the most advanced commercialized applications of CVD diamond whose wear resistance is great because diamond is the hardest of existing materials.

2.1 Cutting Tools

Cutting tools with applications of diamond films include mainly film-coated tools and thick-plate brazed tools. Both types are expected to replace the currently used high-pressure sintered tools (sintered diamond) and single-crystal tools.

2.1.1 Coated Tools

The surfaces of cemented carbide superhard alloy tools or ceramic tools are coated with 5-30 μm thick diamond films. Mitsubishi Materials Co. and Fujietsu Co. in Japan and De Beers and Norton Co. abroad have commercialized coated tools. A photograph of the appearance of diamond-coated tools DC46 manufactured by Mitsubishi Materials is shown in Fig.1.

Since the base material is cemented carbide, various shapes of tools are feasible. Diamond can not be used for machining steel and cast iron because it easily reacts with iron-based materials at high temperatures. The substances that can be worked with diamond are limited to non-iron metals such as copper and aluminum, ceramics, and plastics. In particular, demand for the machining of aluminum has increased with an increase in the applications of light-weight aluminum in automobiles and home appliances. It is difficult to obtain clean-finished surfaces of aluminum because aluminum is soft and causes deposition easily. However, diamond has poor wettability with aluminum, causes no deposition, and therefore can make clean-finished surfaces. Figure 2 shows a fractured surface

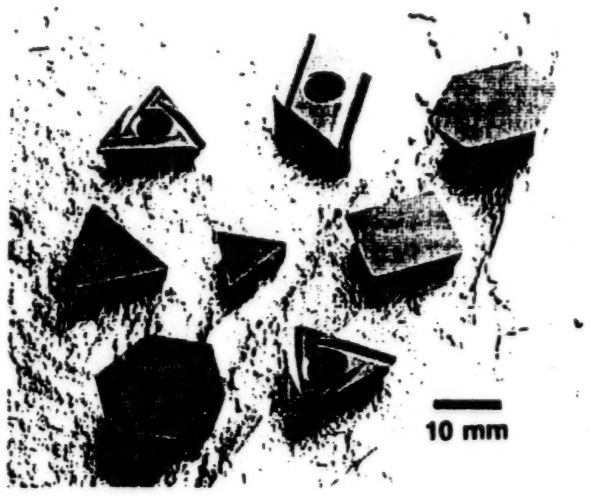


Fig.1. Photograph of diamond-coated tools DC46

of DC46, whose surface has a diamond coating of about 5 microns in thickness. The surface finish of aluminum alloy worked with the DC46 tool is compared with that worked with the cemented carbide tool in Fig.3. The surface worked with the diamond-coated tool is glossy. Figure 4 shows the cutting edges of tools after the milling of aluminum alloy (containing 12% Si) at a high speed of 1000 m/min. While a thirty-minute processing caused wear on the cemented carbide tool, no wear was observed on the diamond-coated tool, which showed superior wear resistance. Figure 5 shows examples of users' tests with DC46.

Diamond-coated tools showed a processing life span three times longer than that of cemented carbide tools for the boring of aluminum alloy and the profiling process of cast aluminum alloy pieces. The face milling of aluminum alloy is a process performed on the cylinder heads of automobile engines. Diamond-coated tools for this process showed a processing life span eighteen times longer than that of cemented carbide tools. This is a good example for demonstrating the features of diamond-coated tools. Sintered copper alloy is used for oil retaining bearings and surface smoothness is critical. The processing life span of diamond-coated tools is ten times longer than that of sintered diamond tools. This may be because chipping of sintered diamond occurs due to the reaction between the binder metal in sintered diamond and copper whose temperature rises remarkably in the cutting process. On the other hand, diamond-coated tools contain no binder metal and have an advantage for machining copper. For the machining of graphite, in most cases diamond-coated tools showed good results because there was no great mechanical impact incurred in the processing of graphite and the wear was mainly caused by the rubbing of graphite particles.

The problems with diamond-coated tools is the adhesion strength of the diamond layer. Each manufacturing company has been trying various methods. The machining of aluminum alloy with a high content of silicon (for example, aluminum alloy containing 18% silicon, A390), whose practical use will begin soon, requires tools with high wear resistance. For such machining, the thickness of the diamond layer should be over 10 microns and the adhesion strength of the diamond layer is critical. This problem, however, has been overcome.[10] Since the increase in the market availability will reduce cost, wider applications of diamond-coated tools can be expected in the future.

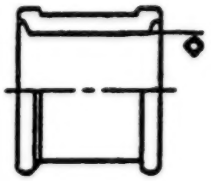
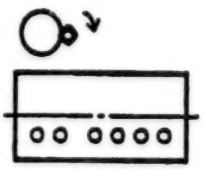
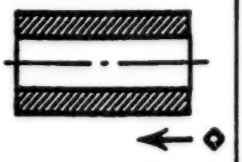
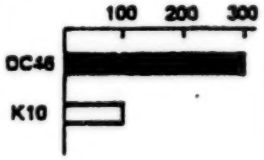
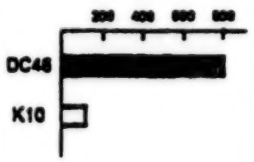
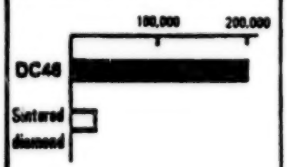
2.1.2 Diamond-Coated Drill Bit and End Mill

These tools are included in the area of coated tools but are described separately because the effect of diamond coating is remarkable. Fujietsu Co. has commercialized the drill bits, which are useful for drilling aluminum alloy. Drilled holes in aluminum pieces are usually deformed because of the nature of aluminum deposition mentioned earlier. However, with diamond-coated drill bits, almost perfectly circular holes can be made which help later processes such as reaming and threading.[11] Although rapid progress in this area can be expected hereafter, there are still problems such as that the conventional way of re-grinding superhard alloy drill bits can not be applied to coated ones and that it is difficult to respond to each special drill bit shape which is more common in a particular field than standard shapes. End mills are also often used for machining aluminum. When these tools are used for slotting, stronger adhesion of diamond layers onto the tools is required because their intermittent cutting mechanisms differ from those on tools for drilling. Commercialization of end mills has not succeeded yet but is promising.

2.1.3 Thick-Plate Brazed Tools

CVD diamond thick plate of 0.2-0.5 mm in thickness is brazed onto the surface of superhard alloy cutting tools in a similar fashion as sintered diamond plate brazed tools. Sumitomo Electric Industries commercialized these tools in Japan. Figure 6 shows the wear resistance of a CVD diamond brazed tool compared with other tools.

When materials difficult to process such as A-390 are cut with these tools, the performance difference between CVD diamond brazed tools and others is clear. CVD diamond brazed tools contain no binder metal and have advantages over sintered diamond brazed tools. On the other hand, since the performance difference for machining general aluminum alloys is not great between CVD diamond and sintered diamond brazed tools, the cost difference is important. CVD diamond has the advantage that it does not need expensive manufacturing equipment such as high pressure apparatus. Large area deposition can be done with the hot filament method but

Processing	Boring	Face Milling	Outer Diameter
Materials	Al alloy 	Al alloy (12%Si) 	Sintered Cu alloy (Cu-10%Sn) 
Cutting Speed	800m/min.	1000m/min.	55m/min.
Feed	0.3mm/rev.	0.06mm/edge	0.05mm/rev.
Depth of Cut	0.2~0.3mm	0.5mm	0.02mm
Cutting Oil	Wet	Wet	
Results	Number of processing 	Number of processing 	Number of processing 

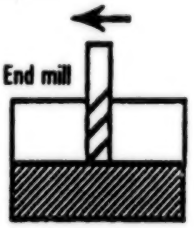
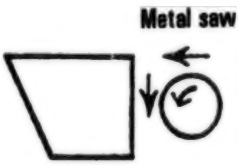
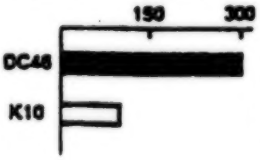
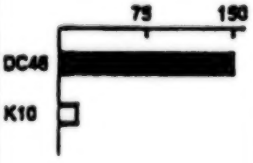
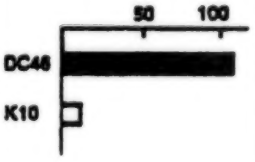
Processing	Profiling	Chamfering	Slitting
Materials	Cast Al alloy 	Graphite 	Graphite 
Cutting Speed	800m/min.	94.2m/min.	664m/min.
Feed	0.3mm/rev.		
Depth of Cut	0.2~5.0mm		
Cutting Oil	Wet	Dry	Dry
Results	Number of processed pieces (pieces/corner) 	Number of processing 	Number of processing 

Figure 5. Examples of the practical use of diamond-coated tools

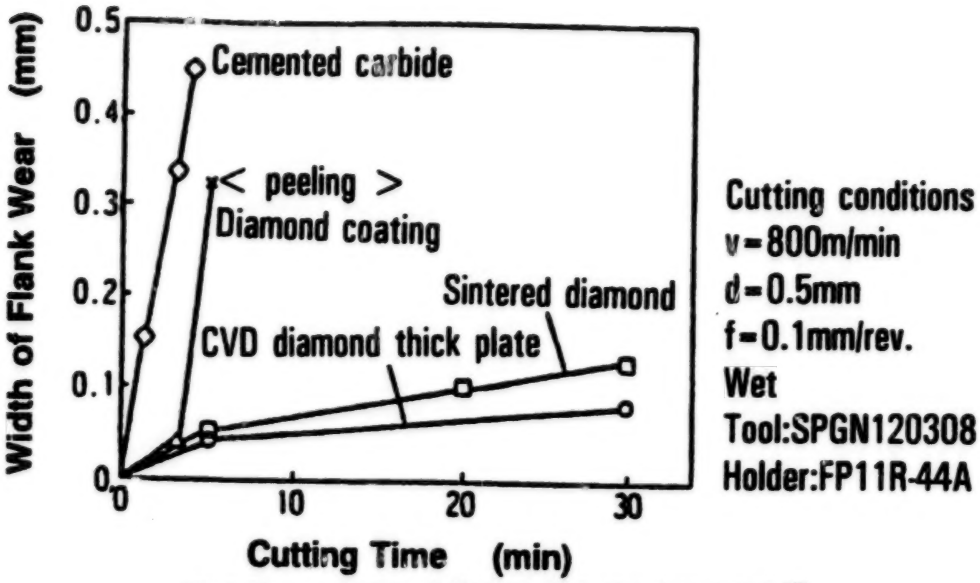


Fig.6. Wear resistance of diamond thick-plate brazed tools[12)]

it takes a long time for synthesis due to its slow deposition speed. With the arc plasma method, the deposition speed is fast but the deposition area is small. How to reduce the cost of CVD diamond compared with high-pressure sintered diamond is a future issue.

3. Applications of High Elastic Modulus

Diamond has a high elastic modulus as is clearly seen in Table 1. Products using this property include speaker diaphragms and X-ray lithography masks.

3.1 Speaker Diaphragms

Light-weight materials with high elastic moduli are needed for high-frequency sound speakers (tweeters). Diamond is an ideal material. Applications of CVD diamond for speaker diaphragms have been tried and partially commercialized. Figure 7 shows the frequency dependence of the acoustic pressure level with a diaphragm made of aluminum oxide coated with diamond.[13)]

Diamond coating has improved performance in the high frequency range and sound reproduction up to a maximum of 50,000 Hz has been obtained. In addition to the diamond coated diaphragm, a complete diaphragm has been made of diamond. The cost of the diamond diaphragm is high but its performance is greatly superior to that of a coated one. The problem in this area is that a large market can not be expected in spite of good performance because individual customers have different tastes in which sound qualities they prefer in a speaker and so one model can not be universally appealing. It is also difficult to mass-produce one model at very low cost.

3.2 X-ray Lithography Masks

The X-ray lithography diamond mask is a part of applications in several fields including electronic materials and optical and mechanical properties due to its relation to the transmittance of X-ray and visible light beams, and also its high elastic modulus of 1-2 micron films. A schematic of X-ray lithography is shown in Fig.8.

The more the integration in LSI, the narrower the line width of printed circuits. When the line width of printed circuits is narrower than 0.2 microns, short-wavelength soft X-ray beams (synchrotron radiation light) is required instead of conventional photoresist using visible light beams. Materials for the mask should have high transmittance of X-ray and also visible light (633 nm He-Ne laser) for position adjustment. The mask also should be strong enough to support patterns made on it. Considering these requirements, the diamond thin film is the best candidate and the development of diamond masks has been pursued.[15),16)] Internal stress in diamond thin films depends on growth conditions and film thickness. X-ray lithography masks should be under tensile stress. Internal stress changes from compressive to tensile stress with increasing film thickness as shown in Fig.9.[15)]

Films thicker than 1.5 μm are under tensile stress. Figure 10 shows a photograph of 1.6 μm-thick diamond membrane.

The optical transmittance of this membrane is 50-60% and is close to the practical level. The future of this field depends on the manufacturing technology trend of VLSI and has a potential for massive demand.

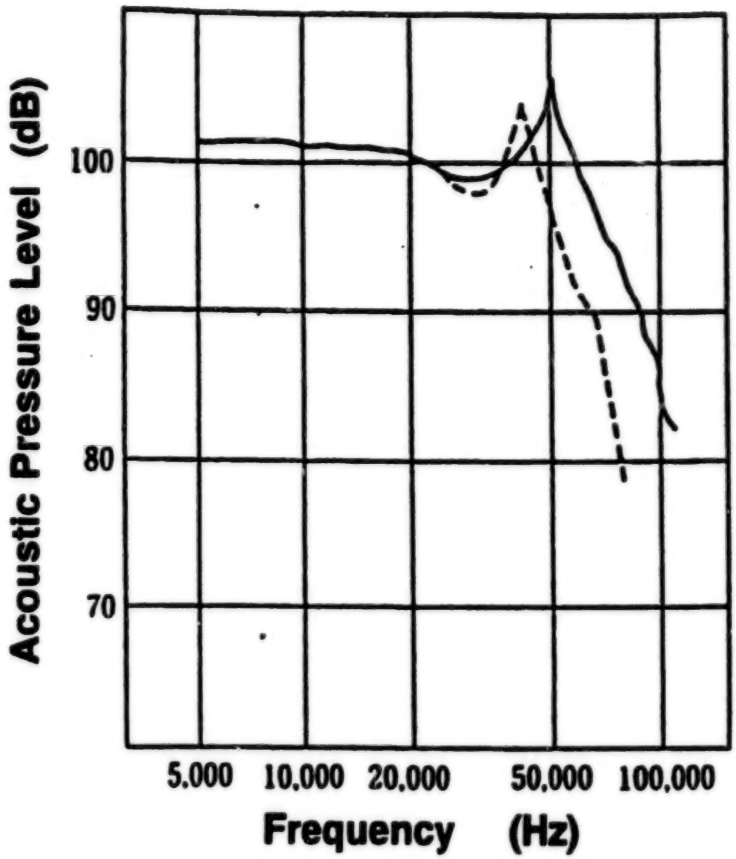


Figure 7. Frequency characterization of alumina diaphragm with diamond coating (full line) and without diamond coating (broken line)[13]

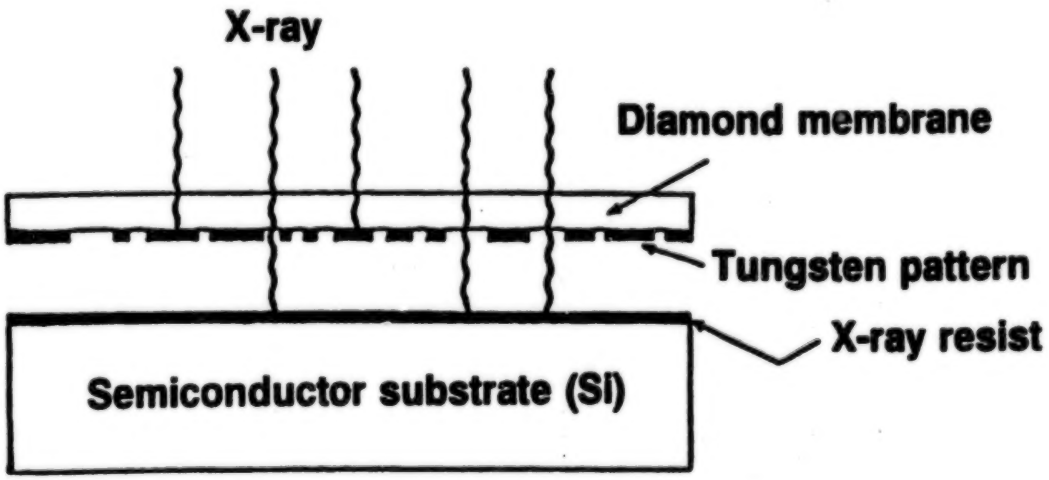


Fig.8. Schematic of X-ray lithography

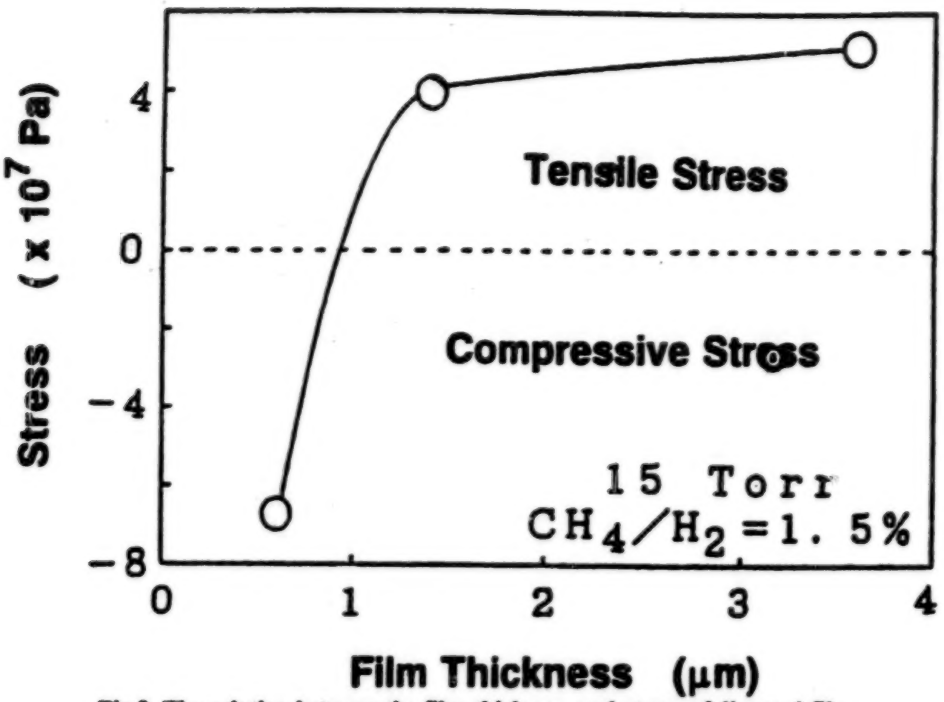


Fig.9. The relation between the film thickness and stress of diamond film

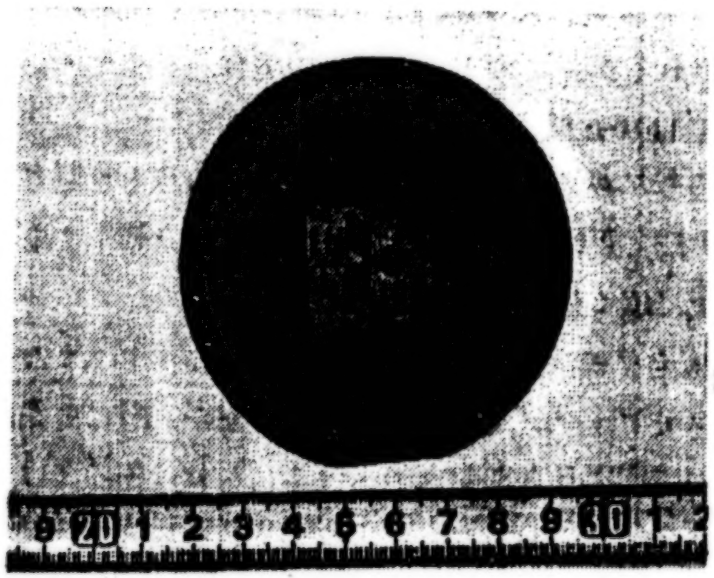


Fig.10. Diamond membrane

speaker and so one model can not be universally appealing. It is also difficult to mass-produce one model at very low cost.

and is close to the practical level. The future of this field depends on the manufacturing technology trend of VLSI and has a potential for massive demand.

4. Conclusions

Applications of mechanical properties of diamond films were summarized. The wide applications have progressed in the field of machining tools and future growth is also promising. In particular, the amount of light-weight alloys including aluminum consumed will increase as continued development of light-weight automobiles and home appliances are pursued. Both diamond-coated tools and diamond thick-plate brazed tools are necessary for machining aluminum alloys.

Further improvements in performance and cost reductions will be necessary to respond to future demand. TAB bonding tools for LSI, which was not described here, is also the application of wear resistance in addition to the good thermal conductivity of diamond. Further understanding of the properties of diamond is important to exploring the applications related to the properties. At the same time, the development of coating technology at lower cost and lower temperature will be required. For example, if a low temperature coating to make protection layers for plastics will be realized, the application area will widen considerably.

Diamond coating technology just entered the stage of practical use. Technology development matching commercial products will be required hereafter. Staff members for development in industries are expected to make more efforts to pursue the applications of diamond coating.

References

1) B. V. Spitsyn, B. V. Deryaguin: USSR Inv. Certif. No. 339134 (1956)

2) W. G. Eversole: USP 3030187, 3030188

3) A. Aisenberg and Chabot.: J. Appl. Phys **42** (1971), 2953

4) C. Weissmantel: Thin Solid Films, **72** (1980) 19

5) B. V. Spitsyn, L. L. Bouilov and B. V. Deryaguin: J. Cryst. Growth **52** (1981) 219

6) S. Matsumoto, Y. Sato, M. Kamo and N. Setaka: Jpn. J. Appl. Phys. **21** (1982) L183

7) M. Kamo, Y. Sato, S. Matsumoto and N. Setaka: J. Cryst. Growth, **62** (1983) 642

8) S. Matsumoto: J. Mater. Sci. Lett. **46** (1985) 146

9) Y. Hirose, S. Amanuma and K. Komaki: J. Appl. Phys. **68**

10) J. A. Herb and Frank Cerio: ADC'93, 2nd Int. Conf. on the Applications of Diamond Films and Related Materials. M. Yoshikawa, M. Murakawa, Y. Tzeng and W. A. Yarbrough (Editor) 181 (1993) MYU

11) K. Kanda, S. Takehana, S. Yoshida, F. Shimakura and K. Ishigane: *ibid.* 565 (1993) MYU

12) T. Nakamura and T. Nakai: FC Report, 10, **8** (1992) 278

13) N. Fujimori: Trend of Development and Applications, No. 3, New Diamond Forum, 1988

14) H. Windishman and G. F. Epps: J. Appl. Phys. **68** (1990) 5665

15) K. Marumoto, H. Yabe, Y. Matsui, H. Yamashita and N. Kikuchi: Jpn. J. Appl. Phys. **31** (1992) 4205

16) H. Yoshikawa, N. Kikuchi, H. Yamashita, Y. Matsui and K. Marumoto: ADC '93, 2nd International Conference on the Applications of Diamond Films and Related Materials: M. Yoshikawa, M. Murakawa, Y. Tzeng and W. A. Yarbrough (Editor) 445 (1993) MYU

17) T. Nakamura, K. Tanaka, T. Yashiki, Y. Kumasawa, N. Fujimori, T. Nakai, and S. Nakaya: 4th Diamond Symposium Abstracts, 75 (1991), New Diamond Forum

High-Temperature Structural Design of LE-7 Main Engine Used in H-2 Rocket

95FE0220 Tokyo MITSUBISHI JUKO GIHO in Japanese Nov 94 pp 423-426

[Article by Kiyoshi Andoh, Masashi Kitade, Technical Headquarters, Keiichi Hasegawa, Mitsumasa Sakamoto, Nagoya Guidance and Propulsion Systems Plant, Mitsubishi Heavy Industries, Ltd., and Yukio Fukushima, National Space Development Agency]

[FBIS Translated Text] Abstract: The performance of the LE-7, which is the main engine for the first stage of the H-2 Rocket, is at the top level on a world-wide scale, and in order to make it compact, a two-stage combustion cycle like that used in the U.S. space shuttles was employed. Because of this, the main injector, which is a high temperature part, is used under severe temperature and pressure conditions. In other words, there is very large thermal stress because of a temperature change of about 800 in atmospheric gas temperature over several seconds during start-up and shut-down, and in addition, there is internal pressure stress. Because of this, it has been necessary to assure sufficient structural integrity using failure mode (fatigue, creep, ratchetting and brittle fracture) countermeasures in the high temperature design and actively adopt a damage tolerant design in which small pre-existing cracks will not produce failures during the design life.

1. Introduction

We have been successful in developing and making the first launch (4 Feb 1994) of the domestically built H-2 Rocket, which has the capability of launching two-ton class geostationary satellites. In this report, we will deal with the LE-7 first stage main engine, the most important element in the development of the H-2 Rocket, and we will discuss the details of solving various problems in the high-temperature structural design and improvements in it.

2. LE-7 Structural Design Concepts

2.1 Utilization Conditions

In order to increase the propulsion/weight ratio and specific propulsion, the LE-7 uses a two-stage combustion cycle with liquid hydrogen (-273°C) as the fuel and liquid oxygen (-183°C) as the oxidizing agent like the engines for the U.S. space shuttles. In addition, the combustion time during launch is just 350s, and it is not reused. However, multiple firing tests were necessary to assure engine performance, and in order to insure structural integrity, a life of 12 firings and total combustion time of 1,720s was required.

2.2 LE-7 Structure

Figure 1 shows the appearance of the engine. Forged (AMS 5662) and rolled (AMS 5596) INCO 718, a deposition hardened Ni based alloy, were used as the main reinforcing materials. These have face centered cubic lattice crystal structures; the strength is high from extremely low temperatures to 650°C, and they have good welding characteristics. Tungsten inert gas welding (TIG) and electron beam welding (EBW) are used as the welding methods.

Since the combustion chamber (inner cylinder: copper alloy and electroformed copper; outer cylinder:INCO 718) and nozzle skirt (cooling tube: A 286; reinforcing ring: INCO 718) are cooled by liquid oxygen, all areas besides those in contact with combustion gasses are in the low temperature range of -230° to -80°C. In addition, the pressure inside the cooling path is high at 280 kgf/cm^2, but we can confirm structural integrity with pressure tests.

On the other hand, the main injector (body and manifold: INCO 718; element: HAYES 188) shown in Fig. 2 is one of the parts under the most severe conditions in terms of high-temperature strength. A very large temperature difference, with the high-temperature parts at 600°C and the low temperature parts at -170°C, arises during rated combustion, and the internal pressure reaches 150-220kgf/cm^2. In several seconds after ignition the primary combustion gasses go from room temperature to 600°C, and since there is sudden cooling with the liquid hydrogen purge that occurs with shut-down, there is a large thermal stress at start-up and shut-down in addition to the stress at rated combustion. The main problem in the high-temperature structural design of the LE-7 was the main injector, which is one of the parts with the most severe high-temperature strength conditions, in other words, the establishment of a design for a heat resistant and pressure resistant welded structure.

2.3 Troubles with Structural Strength

As an example of the troubles with main injector high-temperature strength that occurred during development testing, we have the cracking in the TIG welds of the hydrogen heat exchange assembly that occurred in the 18 June 1992 burn tests. The cracks occurred at the toe of the back bead of the TIG weld for the inside surface of the liquid hydrogen turbine manifold and heat exchanger elbow; the crack started with four firings, and it went quite deep into the 7mm thickness. With the fifth firing test it could be thought of as a dangerous failure. In other words, the damage conditions that should be given the most care and prevented are the dangerous conditions resulting from crack development and propagation in the weld areas. Therefore, it was naturally necessary to use appropriate evaluation methods for this in the structural design and to use materials with excellent strength characteristics for this kind of damage in order to assure structural integrity.

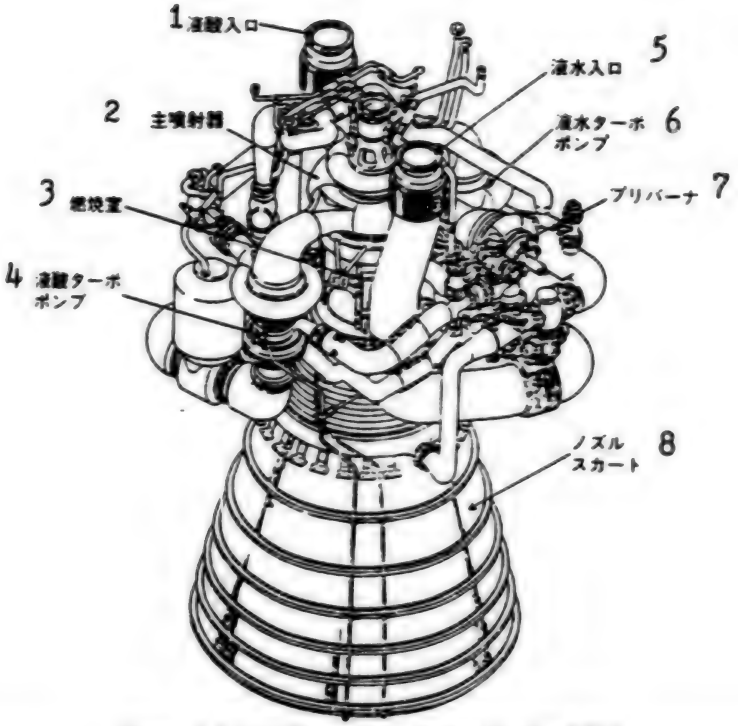


Figure 1. Liquid-Propellent Rocket Engine LE-7

Key: 1. liquid oxygen inlet; 2. main injector; 3. combustion chamber; 4. liquid oxygen turbo pump; 5. liquid hydrogen inlet; 6. liquid hydrogen turbo pump; 7. preburner; 8. nozzle skirt

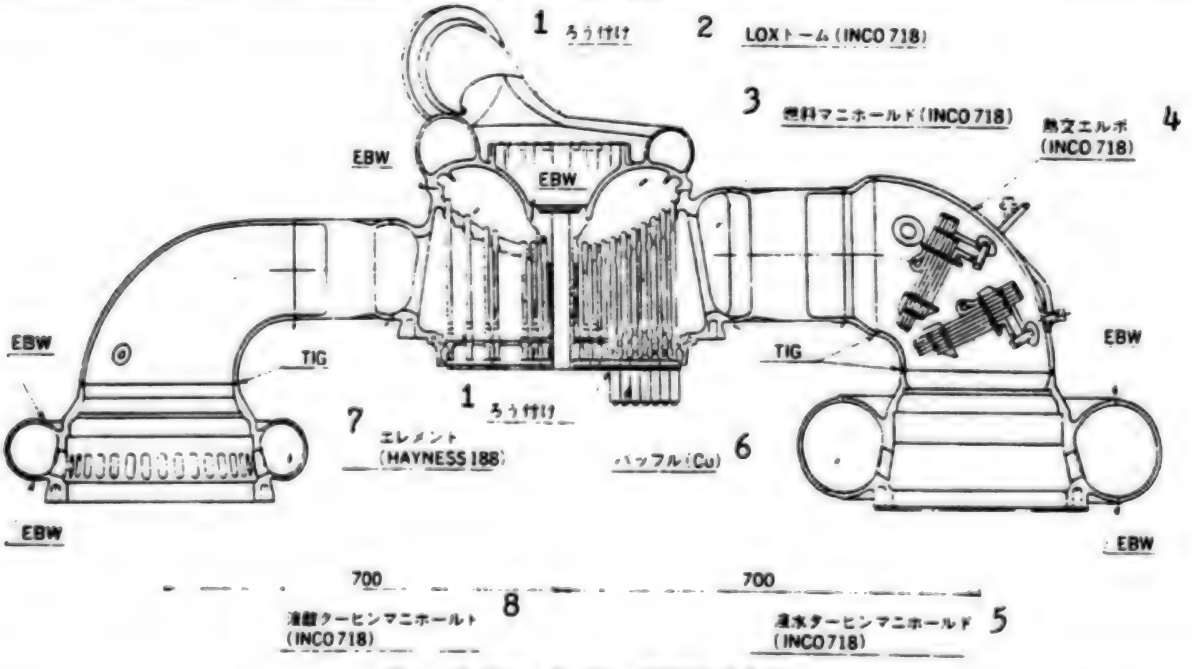


Figure 2. Cross-Section of Main Injector

Key: 1. soldering; 2. LOX dome (INCO 718); 3. fuel manifold (INCO 718); 4. heat exchanger elbow (INCO 718); 5. liquid hydrogen turbine manifold (INCO 718); 6. valve (cu); 7. element (HAYNESS 188); 8. liquid oxygen turbine manifold (INCO 718)

2.4 Concept of High-Temperature Structural Design

We will limit our discussion to the main injector, which is representative of the high-temperature parts. Table 1 gives a summary of the failure modes to be prevented and the limited loads. The stresses obtained through analysis can be divided into primary stress, which is load control stress, secondary stress, which is mainly displacement control stress and peak stress, which is added through the concentration of notch stress. As can be seen in Table 1, limited loads were established to prevent plastic deformation, ductile fracture, creep damage, unstable fracture, progressive deformation like ratchetting and fatigue failures due to fatigue or creep, all damage modes corresponding to these stresses. The safety factor (S.F.) is given as the load safety factor for each stress and the life safety factor for the lifetime number of firings.

Failure Modes and Limited Loads

Stress	Failure Mode	Limited Loads
primary stress P_m	ductile fracturecreep fracture	$P_m<\sigma_y$/S.F. (S.F.=1.1)
	unstable fracture	$K_I<K_{IC}$ when K_I is derived it includes S.F.=1.1
primary (film + bending) stress P_m+P_b	plastic deformation	$(P_m+P_b)/\sigma_y<(1/S.F.)[3/2(1-P_m^2/\sigma_y^2)+P_m/\sigma_y]$ (S.F.=1.25)
(primary + secondary) stress	ratchet propagation	kept in an extreme shake-down using Bree line diagrams
(primary + secondary + peak) stress	creep fatigue	$D_C+D_f<1$ (sum of linear damage) D_C:creep damage (S.F.=10) D_f: low cycle fatigue damage (S.F.=4)
	high cycle fatigue	under MIL-HDBK fatigue limit lifetime S.F.=4 load S.F.=1.5

First we prevent large deformations and cracks. We actively incorporated a damage-tolerant design that does not allow cracks to progress to dangerous conditions during the design life, the required life multiplied by the safety factor, when there are pre-existing cracks or defects or when cracks occur with initial use. This is the major feature of the high-temperature structural design of the LE-7 main injector. In addition, among the highly constrained production processes, we examined the solution treatment conditions, improved strength characteristics and assured structural integrity. In the following, we will limit our discussion to these two points.

3. Improvement of INCO 718 High-Temperature Strength Characteristics

The INCO 718 TIG and EBW welds have lower strength, ductility and toughness than the base material. The tensile properties, fracture toughness, fatigue strength, creep strength and crack propagation characteristics of these are the basis for structural strength design, and we first obtained data on these at room temperature and 600°C in air and we obtained data in oxygen, according to necessity.

The strength characteristics of INCO 718 change greatly with heat treatment after welding. Originally, the main parts of the main injector underwent two low-temperature agings (720°C x 8h + 620°C x 10h) or low-temperature solution treatment (955°C or 980°C x 1h) + two low temperature agings, but since we deduced that the ductility and toughness were insufficient, this was improved to post-welding high-temperature solution treatment (1045°C x 1h) + two low-temperature agings as the result of various examinations.

The details are as follows. A solution temperature of 1030°C or more is necessary to improve the ductility and toughness of INCO 718, and since the melting point of the copper material in the baffle is 1080°C, we set the solution treatment temperature at 1045°C in view of furnace margin. On the other hand, first stage soldering of the elements through which the liquid oxygen flows has conventionally been 1065°C. Considering furnace temperature control and temperature distribution, there is not much margin for 1045°C, there was a need for developing solder materials with a melting point of 1100°C. In addition, the second stage soldering temperature has conventionally been 980°C, so there was a need to change to a process in which the soldering is done at the same time as 1045°C solution treatment. 1045°C high-temperature solution treatment was made possible by developing high-temperature soldering materials and making large changes in the process.

While the fracture toughness of material that had undergone one high-temperature aging (760°C x 10h + 650°C x 10h) after high-temperature solution (1045°C x 1h) was improved a little, it was found to be worse at 600°C. The reason is thought to be that the aging process caused Nb-Ti-C and Nb-Mo deposition to progress, and even though tensile strength was sufficient, ductility and toughness were not improved very much.

Next, while material that underwent one low-temperature aging (720°C x 8h + 620°C x 10h) after high-temperature solution showed improvement in toughness and ductility, it was found that the tensile strength of the base material and the 0.2% proof stress was lower than the AMS standards which were the design

base (normal temperature 0.2% proof stress $\sigma_y > 105$kgf/mm^2, tensile strength > 126kgf/mm^2). It was assumed that this was due to insufficient aging, and with two low temperature agings, both proof stress and tensile strength as well as toughness and ductility were improved. Because of the above, we decided to carry out 1045°C high-temperature solution treatment + two low temperature agings after welding.

(1) Tensile strength: After thermal processing (1045°C ST + two low-temperature agings), the material satisfied the AMS standards (room temperature 0.2% proof stress $\sigma_{0.2} > 105$kgfmm^2; tensile strength $\sigma_B > 126$kgf/mm^2) for the base material. In addition, there was a large improvement in contraction.

(2) Fracture toughness: Figure 3 shows the effect of heat treatment on fracture toughness. The higher the solution treatment temperature is, the greater the improvement in fracture toughness. In addition, there are small improvements in fracture toughness when the test temperature rises for cases in which there is no solution treatment and ones in which the solution treatment temperature is under 1000°C, but when the solution processing temperature exceeds 1000°C, it tends to deteriorate a little as the test temperature increases. This tendency can be understood as meaning that, while there is an improvement in contraction with the temperature increase, there is a larger decrease in tensile strength. This tendency is also confirmed by the test data of W. J. Mills.[1)]

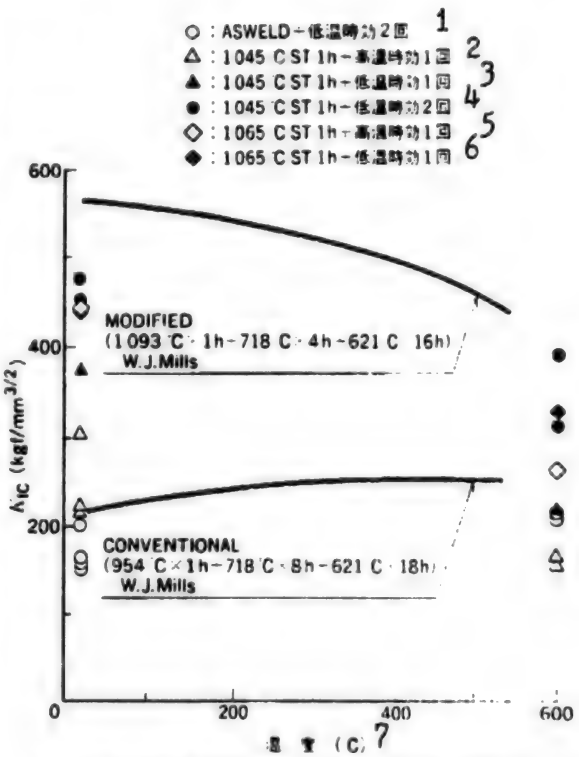
(3) Low cycle fatigue strength: Figure 4 shows the low cycle fatigue strength. Since the usage conditions are extreme, we carried out axial distortion control fatigue tests in the large range of 1-5% and thermal shock tests of 6-7% distortion.

The figure shows the envelope of test effects (using the new Manson equation[2)]). This confirms a marked improvement in the distortion range above 1% with high-temperature solution treatment. The lower limit of the variation showed an approximate tripling of life.

The design curve sets the crack life of the actual structure at ½ of the test sample failure life (lower limit in tests),[3)] and considering the fact that the hydrogen atmosphere has the effect of reducing ductility slightly, the life safety factor was set at 4.

(4) Creep: Compared with material that has not been solution treated, flat base material that has undergone 1045°C high-temperature solution treatment has lower creep fracture strength, but flat joint creep fracture strength is about the same. On the other hand, notch joint material that has undergone 1045°C high-temperature solution treatment has a greater creep fracture life than flat material.

(5) Crack propagation: Both the fatigue crack propagation rate and creep crack propagation rate for 1045°C



Effect of Heat Treatment on Fracture Toughness

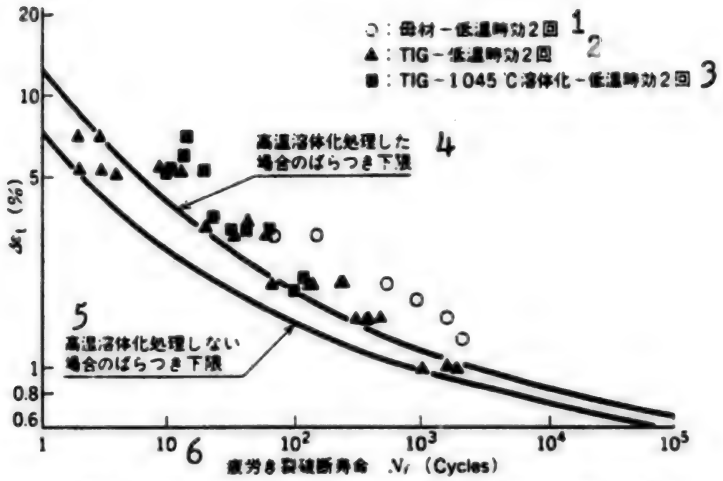
Key: 1. ASWELD + two low temperature agings; 2. 1045°C ST 1h + one high-temperature aging; 3. 1045°C ST 1h + one low-temperature aging; 4. 1045°C ST 1h + two low-temperature agings; 5. 1065°C ST 1h + one high-temperature aging; 6. 1065°C ST 1h +* one low-temperature aging; 7. temperature (°C)

high-temperature solution processing and two low-temperature agings after TIG welding are roughly the same as those with two low temperature agings after TIG welding and the data in the *Aerospace Structural Metal Handbook.*

The fatigue + creep crack propagation rate under 350s tension, which was measured under conditions much more severe those in the actual unit, could be evaluated as a safe measurement with linear calculations of the fatigue crack propagation and creep crack propagation rates. However, the actual stress level during rated combustion is small due to the present stress reducing structure, and the effects of creep can be ignored.

4. Use of Damage Tolerant Design

We actively used the concept of a damage tolerant design that not only prevents cracking but also presumes the existence of defects that cannot be found through non-destructive inspections. Basically, damage tolerant design assumes that there are defects that cannot be detected by inspection in a product that shows up as



Effect of Heat Treatment on Low Cycle Fatigue Strength

Key: 1. base material + 2 low-temperature agings; 2. TIG + two low temperature agings; 3. TIG + 1045°C solution + two low temperature agings; 4. lower limit of variation with high-temperature solution treatment; 5. lower limit without high-temperature solution treatment; 6. fatigue failure life N_f (cycles)

either having or not having defects in nondestructive inspections, and design is done so that the product can be guaranteed not to progress to final unstable failure through crack progress analysis and periodic inspection.

The structural troubles with the main injector during the development of the LE-7 were all crack and crack progress related, and the cause of most of them were small initial cracks that were not detected. Therefore, three things were necessary: improvements of the reliability of product production (machining aspect), clarification of the permissible initial defect dimensions for design life with the introduction of damage tolerant design (design aspect) and confirmation of no defects greater than the permissible initial defect dimensions through nondestructive inspections (quality assurance aspect).

4.1 Structure

Production quality of the weldments, where it is easy to have microdefects, was improved in three ways. First, the welding design was improved. The welding lines were moved to positions with lower stress. In addition, in order to reduce the mismatch of the weld grooves, the fuel manifold was made by forging and machining rather than by the conventional sheet metal formation. Second, the welding methods were improved. Sizing processing was carried out on the grooves that still use sheet metal formation. Furthermore, dimensions are matched and the welding done in the current processing, and a flush bead is used on the inside and outside surfaces of high-temperature parts from the turbine manifold to the fuel manifold in order to reduce the concentration of stress at the toe of the bead. Third, we improved the material characteristics as discussed above.

4.2 Quality Assurance

In order to assure that there are no defects above the permissible dimensions in all of the weldments, we increased the use of nondestructive inspections and clarified the defect detection limits. First, X-ray inspections of the welds were carried out after welding. Second, in order to reduce stress concentration and prevent initial cracking, flush beads were used, and after etching of these locations, fluorescent penetrant testing was carried out. When there were indications of defects, the flush beads were redone. In addition, as a result of examining the limits to defect detection, we confirmed that defects of 0.25mm or greater could be detected. Third, test pieces with artificial defects were prepared and ultrasonic flaw detection used for places that could not be inspected by fluorescent penetrant testing between burn tests, and these were monitored during combustion tests.

4.3 Design

It is possible that microcracks that are difficult to detect will remain after production. We could not confirm crack progression for most of these, but there is the danger that cracks will progress and cause trouble if they exist in high-stress areas. In addition there is a limit to detection by fluorescent penetrant testing, and it is difficult to produce something with no cracks at all. Therefore, we actively made the back beads flush, and along with eliminating initial defects, we used a damage tolerant design so that the design life would be satisfied even if there were microcracks and cracks progressed with each firing test. In other words, we carried out a crack propagation analysis to find the permissible initial defect dimensions for damage tolerance. Actually, there

are many flat cracks in which the ratio of the crack length to depth is large. Thus, we made the full crack be the condition for initial cracks. In addition, crack propagation analysis was verified and corrected through a reverse analysis of actual troubles using Forman's equation.[5]

$da/dN=C \times \Delta K^m/[(1-R)K_{IC}-\Delta K]$

Here,

ΔK: range of stress expansion coefficient

K_{IC}: fracture toughness

$R=\sigma_{min}/\sigma_{max}$: stress ratio

C and m: material constants

The design life requirement is 48 times, the required life of 12 times the safety factor of 4. We found the maximum permissible initial crack depth for crack propagation to unstable failure with 48 uses. While it was necessary to carry out combustion tests that reflect the inspection period, the permissible initial crack dimensions even for locations with the severest stress were greater than the 0.25mm defect detection limits of nondestructive inspection, and the design life could be satisfied.

5. Summary

We developed the LE-7, which has world-class performance, as the first stage engine for the H-II Rocket on which Japanese space development is depending. The propulsion is ten times that of the previous LE-5 liquid fueled rocket engine, and with the use of a two stage fuel cycle, it is used under severe temperature and pressure conditions, and they are particularly severe in terms of the high-temperature strength of the main injector. Thus, we reassessed the high-temperature strength and added improvements and countermeasures for success in assuring the structural integrity for the LE-7.

(1) LE-7 high-temperature strength design standards were clarified.

(2) Countermeasures for the predicted damage modes were implemented.

(3) Damage tolerant design concepts were used uniformly on each area of design, machining and quality assurance.

References

1) Mills, W. J.: "Effect of Heat Treatment on the Elevated Temperature Tensile and Fracture Toughness Behavior of Alloy 718 Weldments," Hanford Engineering Development Laboratory, HEDL-TME-80-18 (1980)

2) Iida, Kunihiro: "Metal Fatigue—Failure and Prevention (2)," Kyowa Giho, No 348 (1987)

3) Iida, Kunihiro: "A Consideration of Fatigue Design Curves Based on Low Cycle Fatigue Life Distribution Shape," Nihon Zosen Gakkai Ronbunshu, No. 133 (1973)

4) U.S. Department of Defence, *Aerospace Structural Metals Handbook* (1991)

5) Forman, R. G., et al.: "Numerical Analysis of Crack Propagation in Cyclic-Loaded Structures," Trans ASME, Ser D, Vol 89 (1967) p. 459

Article Views Development of FSX Fighter

OW0704161795 Tokyo BOEI GIJUTSU JANARU in Japanese Feb 95 pp 23-36

[Article by Tomoharu Shibata, managing director of the Electronics Technology General Division, Nakabishi Engineering Co.]

[FBIS Translated Text] Steps in FSX Development

1. Introduction

The FSX was rolled out on 12 January 1995, and entered the final stage of testing in preparation for its first flight. It is premature to discuss this project, which is still underway, prior to this most important period, and it is perhaps not appropriate for someone who is not involved in the present stage of development to write anything. However, the completion of the FSX will come some 30 years after the first budding of some of the technology involved in the project. By then there will be almost no engineers who experienced the whole process, and memories will have dimmed. It is necessary, when considering the FSX, to look back more than 10 years. I had the good luck to participate in a number of fighter-related development projects at Mitsubishi Heavy Industries, and I have undertaken this paper in the hope that my memory of the steps leading to the present will be of use to the readers.

The FSX has been scrutinized from the political and economic perspectives in addition to the aspect of national defense, and there have been many reports on those points. Although development of the aircraft is just one part of the grand project of Japanese-U.S. codevelopment, numerous technicians from both sides have taken part, and the project has made steady progress to reach the current point. I will begin by mentioning the technical activity among aircraft manufacturers with which I have experience.

2. History Prior to Development

2.1 Future Aircraft Technology—Element Research under the 4th Defense Buildup Plan

At the time when the T-2 completed its first flight and modification of the F-1 was being undertaken, various kinds of advanced technology were being developed in other countries.

This included the appearance of several experimental aircraft. For those of us who struggled to provide satisfactory maneuverability to the T-2 by means of mechanical steering equipment with SAS (Stability Augmentation System), the FBW (Fly By Wire) technology introduced in NASA documents made a strong impression as the important technology of the future. Moreover, high-strength FRP (Fiber Reinforced Plastics) using such fibers as boron had begun to be used as primary structural materials in place of GFRP (Glass Fiber Reinforced Plastics), which were widely used as secondary structural materials.

Attention was also concentrated on CFRP (Carbon Fiber Reinforced Plastics), which had relatively great strength and were easy to work with. Research had just begun in Japan, but CFRP was believed to be a treasure that would bring about a considerable reduction in the weight of aircraft.

After that, all the airframe manufacturers took part in aircraft research; we recognized FBW, CFRP and high-maneuverability aerodynamic configuration as technology required by fighters of the future, and began work on them. All involved many unknown factors, and it took several years to produce any results, but this gradually provided a base of new technology and valuable experience.

2.2 CCV Technology—Research Proposed by TRDI [Technology Research and Development Institute]

Looking at world trends, FBW was followed by aircraft designs that used computers for even greater control performance; the CCV (Control Configured Vehicle) concept emerged and brought about an epochal improvement in performance. The YF-16, which was the first CCV aircraft, made its first flight as early as 1974; that led to full-scale development of the F-16. Since it was necessary to build a test plane to acquire CCV technology and to verify and evaluate its effect, the Defense Agency's Technical Research and Development Institute designed a modified T-2 as a CCV research plane, and began research. With the commencement of TRDI-proposed research, research fabrication of a full-scale test plane incorporating various modes—CAS (Control Augmentation System) by means of three-axis DFBW (Digital Fly By Wire), MLC (Maneuver Load Control), DLC (Direct Lift Control), and DSC (Direct Side Force Control)—began the following fiscal year.

Digital control was the most advanced technology of the time. The FBW aircraft in other countries, with one exception, used analog control. To suddenly digitize FBW, with no experience in FBW itself, was a considerable risk, and we were hesitant. But the future promise of the technology was clear, and we decided to go ahead. Following the first test flight in August 1983, there was well over a hundred hours of flight testing within MHI and by the Air Proving Wing, and it was possible to evaluate the effectiveness of the various modes of CCV.

This research fabrication was extremely fruitful, establishing element technology including multiplex signal redundancy management, optimum flight control rules, software quality verification and multiplex signal actuators, as well as technology for new dynamic flight loads, structural vibration, equipment to protect against lightning, and so on. That many problems that subsequently arose during FSX development could be overcome and the development schedule could be maintained is certainly thanks to the fact that many people with experience on the CCV aircraft also took part in FSX development, and could contribute their achievements and confidence. This is not just a matter of technology acquisition in the narrow sense, but includes immeasurable results in the areas of development procedures, development schedules, fostering vendors and so on; it is no exaggeration to say that without the CCV research plane, the FSX would not have been possible. In connection with that, one critical path in the FSX development schedule was flight control system development, but the 4 years and 9 months from beginning of development to the rollout of the FSX was slightly shorter than the period for the CCV research plane, which shows how much was learned.

Incidentally, TRDI's next research proposition, APAR (Active Phased Array Radar), was undertaken by Mitsubishi Electric, and with the end of the C-1 FTB (Flight Test Bed) flight testing, a pioneering APAR for fighters had been realized. That success was the basis for the FSX radar, and is known to have attracted great interest from the United States as a prime example of Japan's advanced avionics.

2.3 Composite Materials Technology—the 3rd Research Center Wing

The usefulness of CFRP technology has been evaluated through the fabrication and flight experience of T-2, C-1 and PS-1 control surfaces as a part of future aircraft research. CFRP canards had been mounted on the CCV research plane and moved steadily in the direction of practical utility, but that movement was accelerated rapidly by development of the XT-4. The XT-4 was Japan's first practical aircraft to use CFRP structures for such things as the horizontal stabilizer, vertical stabilizer, ailerons and speed brakes. The speed brakes, for which MHI was responsible, were formed by assembling tens of parts which were then heated and molded together; this was a forerunner of the co-cured composite structure. Taking the view that the most effective way to quickly increase the ratio of composite materials used in future aircraft, as well as greatly reduce their weight, would be to use them in the thick panels of the wing, TRDI's 3rd Research Center began research fabrication of a composite wing. After establishing the structural style and fabricating test pieces, it completed a co-cured main wing, a structure of almost unprecedented size. The center then tests of static strength and fatigue strength, and confirmed its suitability for practical use.

Such design techniques as optimum fiber distribution (tailoring) and strength analysis, and such manufacturing techniques as processes for molding without voids or warping and defect inspection methods, were established in the process of trial fabrication. There were still many hurdles along the way to manufacture of wings for actual aircraft, but the establishment of this technology greatly boosted confidence, allowed a decision to apply it to the FSX, and promised to reduce aircraft weight to an extent appropriate to the performance requirements. The advanced nature of this technology also attracted the attention of the United States

2.4 System Integration Technology—Computer Fabrication Etc.

Such advanced technology as composite structural materials, titanium alloy structural materials and pulsed Doppler radar were widely adopted in advanced aircraft like the F-14, F-15 and F-16 that appeared in the first half of the 1970's, but what really caught our eye was system integration technology. The key to systems that can navigate correctly and control weapon fire accurately in a complex battlefield environment is software for the central computer. That is a field in which Japan, lacking experience, lags behind.

The modernized F-4 was started at this time, and was given an on-board computer in addition to modernized radar and avionics. Through the development of OFP (Operational Flight Program), man-machine interface evaluation and weapon firing tests, Japan was able to acquire its own system integration technology.

The central computer which is the centerpiece of system integration is rapidly becoming faster and smaller, and has become essential equipment for aircraft of the future. However, no real airborne computers have been developed within Japan. TRDI is engaged in the research fabrication of a fighter aircraft computer with small size, high speed and high reliability to rival world levels, and has confirmed the desired results. At about the same time, it carried out research fabrication of RLG (Ring Laser Gyro), which is a high-reliability inertial sensor, and an integrated electronic warfare system, and has made steady progress accumulating technology in the fields of avionics and software, for which Japan has largely relied on the United States This technology provides the basis for equipment to be mounted when the FSX is developed.

3. Prototype Development

3.1 Determination of Configuration

The decision was made in October 1987 to develop the FSX on the basis of the F-16 (C/D version). At that time, over 2,000 F-16's had been produced and were deployed throughout the world. To further enhance performance, however, design of the Agile Falcon, which had about 30 percent greater wing area, also went forward.

The proposal that General Dynamics (now Lockheed Ft. Worth) made in response to the FSX requirements was close to the Agile Falcon. We thought that the performance requirements could be satisfied if the technological achievements mentioned above were applied to the base in that proposal, and the modification went somewhat deeper. However, the details of the F-16 were unknown, beyond what was in open literature, and it was hard to predict what range of modification would be possible. We started a process of working out the modification needed to meet the requirements, and then faithfully proposed solutions, one by one. It is true that there were requirements that would be difficult to meet with a modification, but in many regards, starting from an established framework was more efficient than beginning our considerations from zero. On the other hand, there were times when we intended to make minimum modifications based on the features of the existing airframe, but struggled with expansion of the scale of modification when requirements could not be met otherwise.

The term "modified aircraft" covers a very broad range, from small modifications where the on-board equipment is replaced, to major modifications that make use of the basic concept to produce a new airframe. One example of a major modification is the change from the Harrier to the AV-8B; I think the modification from the F-16 to the FSX is on that order. The AV-8B was based on the Harrier's concept of a single engine VTOL (Vertical Takeoff and Landing) aircraft, but had an enlarged, redesigned wing and greatly enhanced aerodynamic characteristics; although the external appearance was similar, it was in fact a completely new aircraft with twice the performance of the old one. The FSX continued the F-16's design concept of a compact, single-engine aircraft, but was to have vastly improved mission capabilities as a result of modifications in accordance with requirements.

Setting the configuration was to be done on the basis of two approaches:

1) changing the major measurements and shapes in accordance with flight performance requirements,

2) mounting new equipment and changing the system in accordance with mission requirements.

A representative example of the first approach is the new wing. The wing area, plane shape, thickness and attachment to the fuselage were decided independently from those of the F-16, taking into consideration such things as takeoff and landing performance, turning performance, cruising performance and weapons to be mounted. Externally, the overall configuration does not appear to be much different from the F-16, but aside from the wing, partial changes of the fuselage, increased stabilizer surface, the new engine and various weapons required large-scale aerodynamic analysis and wind-tunnel testing. The work and time required were the same as in development of a new aircraft, except for savings in the work of reducing resistance of the fuselage.

It was hoped that through a series of reviews, it would be possible to make the most of the F-16's strong points, and create an even better fighter.

Examples of the second approach are the adoption of a number of avionics devices including radar, electronic warfare equipment and large displays, and the related development of a huge OFP. The number of LRU (Line Replaceable Units) was also increased considerably. And of course, the FBW/SSV system was updated to take advantage of the results of the CCV research plane.

Changes in the wing, engine, avionics and flight control system almost add up to a new aircraft, and required further changes in the structure and fittings; the result was close to designing an all-new aircraft. In addition to the new structure and new dynamic loads, the equipment, wiring and piping all had to be changed and resized. The policy was to leave attached equipment with no or minimum changes, but that required a process of case-by-case decisions on compatibility with the FSX.

Reduction of weight was a major factor in satisfying requirements. In addition to using composites with 20 percent relative weight for the wing, horizontal and vertical stabilizers and landing gear covers, new alloy materials and lighter equipment were adopted. And although it is not a conspicuous point, what gave the designers the greatest trouble was the matter of mounting additional equipment within an extremely compact airframe, and maintaining space for passage of the related wiring and piping.

Although blueprints and other technical data on the F-16 provided a basis for the modification, in the end it was necessary to draw up new blueprints using CAD [computer-aided design], make again all calculations, perform wind-tunnel and flight-simulation experiments, partial structural experiments, rig experiments, system integration experiments and so on. In this way the aircraft and systems were all rebuilt based on our own judgment, and verified independently, so that we can fulfill the full responsibility of a prime contractor.

The situation was the same at the production site; we studied the F-16 thoroughly but designed our own tools and drafted our own work procedures rather than adopt those of the F-16. In this way we were able to establish a production method suited to Japan. This served to simplify assembly and minimize trouble.

3.2 Design Team

Based on results of earlier domestic development of aircraft, including the XT-2 and XT-4, it was decided to adopt the design team concept for development, and the FSET (Fighter Support Engineering Team) was started up. General Dynamics had little experience in codevelopment; although there was a design team for development of the F-22, in which it was participating at that time, that team was unlike the Japanese mode, in which all members work together in the same location, and it had little understanding of the Japanese team method at first. It may have been because of their pride, but they expressed a very strong desire to have only have interface personnel in Japan, and take the design work back home to do by themselves. During the basic design, there frequently had to be trade offs that involved aerodynamic, structural and operational systems, and it was essential that definite policies be decided quickly and accurately. We were highly confident that it was best to have the team members do the designing in a body, under the leadership of the prime contractor. We stuck to that, and made every effort to persuade them, and consequently were able to start up a Japanese-style team. At that point we were worried that the participation of a large number of General Dynamics engineers would cause a language barrier. The Japanese engineers were primarily people with experience in domestic development. While they could draft documents in English well enough, almost all of them were weak in English conversation, which was a serious problem. Personnel at every level worked hard to upgrade their conversational ability, and could be seen listening to language tapes during their breaks. In the course of repeated meetings with General Dynamics and sectional work with engineers, language ability improved as the project went forward, and that is due entirely to the efforts of all team members. Sections tried to use both Japanese and English in morning assemblies and conferences, and prepared English summaries for documents and English keys for plans so that General Dynamics engineers could understand them and not feel left out. At technical review meetings in TRDI, engineers who were skilled in English provided simultaneous interpretation to allow a smooth flow of ideas; this was well-received.

Up to 300 technical personnel participated in FSET. The Japanese side were mostly people from various aircraft manufacturers with experience in developing the T-2, T-4 and CCV aircraft; the General Dynamics side had more than 20 percent with experience with the F-16. The organization was as flat as possible to allow numerous engineers to work efficiently, and a balance between manufacturers was sought. Basically, the sections were organized on the basis of the responsibilities of each company, but crossover fields like aerodynamics, flight control and maintenance, personnel of all companies were mixed, as in earlier design teams, to make effective use of the experience of team members. There was concern on both sides about the visibility of the work assigned to the Japanese and US sides, but every effort was made to increase the transparency of work content through the meeting method described above, the way documents were handled and some degree of participation of engineers from both sides in each of the sections.

Though we speak of development, the F-16 was the basis, so it was necessary to first study and understand the F-16, just as in the case of licensed production. We made an active effort, including training in Fort Worth to study technical documents to question General Dynamics engineers. The biggest difference from

licensed production was not the acquisition of production know-how, but rather the necessity of know-how for the modification process. Because of the situation in the United States, this point required much effort in the form of consultations and cooperation between the Japanese and U.S. sides at the government and private-sector levels. In the end, however, the experience of the Japanese engineers was shown to be suitable, and there were few obstacles to the design process.

With the passage of time, all members came to share the same vision of fighter development, and it was possible to go through basic design and detailed design as scheduled.

3.3 Transfer of Composite Wing Technology

The transfer of technology for the composite wing was one of the noteworthy events in codevelopment of the FSX. Japan had previously received technology from the United States through licensed production, but this time was just the opposite. Another important point is that while Japan was still in the process of developing a practical wing based on the 3d Research Center wing. It would involve some risk and effort to turn the technology over to the United States immediately in order to build the same wing.

A major component like the wing, particularly one made of composite materials, cannot be designed and manufactured hastily. A step-by-step development procedure including element tests, partial structure tests, machining tests and component fabrication is required. Strength testing was repeated and results were confirmed at each step of model design, process determination, tool development and model fabrication, so that the finished product would be perfect beyond any question.

Therefore, we followed a schedule that had been decided carefully on the basis of experience with the 3rd Research Center wing, and adopted the basic thinking that we would turn the technology Japan developed over to General Dynamics at each step, and it would faithfully follow the same process, confirm that the results were identical, and proceed with the work. The Japanese side constantly put the development details into drawings (fabrication plans and tool plans), specifications (materials, processes and testing) and documents (detailed know-how), then changed them into English and sent them to the United States by the promised date. In addition, we stationed experts at General dynamics to guide the work. Of course, General Dynamics also sent many experts and workers to work sites in Japan. They humbly absorbed detailed know-how and returned to the United States. This work continued for 4 years, and made it possible for General Dynamics to fabricate tools and models, and conduct various test.

Composites, unlike metals, have a frightening characteristic in that slight differences in the process or tools can have an immense effect on the product's quality (dimensions and internal defects) and strength. Japan and the United States were almost identical in terms of facilities, but there were differences in the skill and experience of workers and in ways of working. There was, at first, considerable concern over whether the United States could actually meet schedule and quality requirements even when the technology was transferred. In the first test of simple test pieces, both sides were surprised by the great difference in strength between Japan and the United States. When the processes and equipment were surveyed and precise comparative tests were made, small differences in the test methods were discovered and corrected. This occurence became on opportunity to increase the care taken in future transfers of technology, and thus misfortune was turned into a benefit.

As a result of such assiduous efforts by Japanese and U.S. engineers, the co-cured wing was produced at General Dynamics, and was available without problem and on schedule. The strength test for the final quality confirmation is still ahead, but the day is near when it will be confirmed that the first reverse transfer of technology is a success.

4. Codevelopment

International codevelopment of aircraft in the private sector began with planes like the Boeing 767, and the practice is taking firm shape, but Defense Agency aircraft have a different level of difficulty because they involve factors not present on a purely commercial basis. Because the FSX is an independent Japanese project in accordance with Japan's requirements, the situation is somewhat more relaxed than in the general case of international codevelopment, when an aircraft is jointly developed for several countries. Nevertheless, the United States is the leading country for fighters and U.S. engineers designed the prototype, and so found it unusual to let Japan take the lead in development.

Through the efforts of those involved, it was possible to overcome numerous obstacles and progress to the present point. The steps in that process are summarized below.

(1) Fighter development is the product of years of accumulation of technology. The FSX development was built up on a base of technology covering a broad range from design through production, fostered through various aircraft development projects, beginning with the T-2 and F-1, over more than a decade. The advanced technology that was eagerly cultivated over that period, including CCV, composite materials and avionics, was effectively employed in the FSX, and became the key to satisfying our high requirements. In addition to being the object of reverse technology transfer to the United States, that technology played a great role in the mutual technical exchange between Japan and the United States that included peripheral technology.

I certainly hope that appropriate measures will be taken to continue this technological strength into the next generation, and to develop it further.

(2) This was the first international codevelopment of a Defense Agency aircraft, but domestic experience and methods from various codevelopment projects played a great role, and the effectiveness of Japan's design team method was confirmed. In regard to practical business, however, close scrutiny was required in response to the SOW (Statement of Work) and other contracting practices; the effort for that purpose was quite excessive. There was, at first, frequent confusion because of cultural differences including language, customs and ways of working, but as the project progressed, mutual confidence increased and a unified outlook developed, just as in the case of domestic codevelopment.

I hope that more refined procedures for development management will be realized on the basis of the FSX experience.

(3) When an existing aircraft is modified to meet new requirements, beyond a certain scale, the project will take nearly as much time and effort as developing an all-new aircraft, but the risk accompanying development is in fact diminished. Within the constraints of modification of an existing aircraft, once the policy was set on required specifications and technology to be adopted, development went forward without great confusion because Japan took the initiative throughout and the United States understood Japan's position and cooperated.

I firmly believe that clarification of goals and leadership is an indispensable element in the success of this kind of development.

The primary goals following the rollout are to confirm the design of the FSX through ground tests and system integration tests, and to complete the first flight, without incident, in the restricted environment of Japan. Following that, we must be prepared for a number of trials, including various flights tests and strength testing of the entire aircraft, in order to secure the Director-General's approval.

As personnel are transferred in and out of large projects that take a long time, it is desirable that lessons learned be compiled in a timely fashion, to be applied to development and international codevelopment of new aircraft, which will be of increasing importance as we enter the 21st century.

Finally, I offer my heartfelt thanks to the Japanese and U.S. officials who gave us precise guidance throughout to lead this project to success, and to the many Japanese and U.S. company personnel who offered their cooperation.

Auto Engineering Group Le..der Offers New Year's Greetings

OW1904093795 Tokyo JIDOSHA GIJUTSU in Japanese Jan 95 p 3

[Article by Yoshiro Kimbara, chairman, Society of Automotive Engineers of Japan (JSAE)]

[FBIS Translated Text] A happy new year to everyone.

I hope that all of our members greeted the New Year with their families.

In the last year, 1994, it was often said that the Japanese economy had bottomed out, but we could neither feel a strong recovery nor see future improvement. I think that many of our members were pressed to respond to the yen's rapid rise, exceeding any forecast, in the latter half of the year, working hard day and night to defend Japan's automobile industry. From the deepest part of my heart, I strongly wish that 1995 will show a bright perspective and be a year filled with brightness for you.

Happily for us, JSAE's activities in 1994 went on smoothly thanks to our members' support and cooperation.

The number of members, which fell below 30,000 at the end of fiscal year 1993, recovered to rise above this figure at the end of August 1994. Our conferences in the spring and fall were highly successful. In particular, the fall conference held in the Sendai International Center broke the past record for the number of lectures. AVEC '94, the International Symposium on Advanced Vehicle Control 1994, held in October in Tsukuba under our sponsorship, was attended by more than the expected number of engineers from 12 countries. They had active discussions together. The conference ended in success with the promise to meet again in two years in Germany. Our members, including nine university automotive club members, also attended the 25th international FISITA convention held in Beijing the same month.

For surveying the history of automotive technology, which had been studied by a working group since 1993, the "Automotive Technology History Committee" was organized. Bringing together well-informed persons from the government, universities, and industry, the committee began working in earnest with the JSAE secretariat.

For 1995, we are vigorously making preparations for holding the spring conference and "Technology Exhibition of Humans and Vehicles '95" in Yokohama as usual, and the fall conference in Beppu with the collaboration of our Kyushu Section. In November, we will also host the 8th IPC (International Pacific Conference on Automotive Engineering) in Yokohama under the joint sponsorship of six countries from the Pacific area. I hope many members will attend this conference.

As all of you may be aware of, not only the Japanese automobile industry but all of Japanese society today is coming to a turning point and groping for a new paradigm. JSAE, commemorating at such a moment its 50th anniversary, has been reviewing past activities radically and studying how a scientific organization in the new age should be arranged by establishing the "Operations Restructuring Examination Committee" chaired by former Chairman Marumo in 1994. The report from the committee is expected to be submitted soon. As I personally am entering the second year as chairman, I am determined to undertake in earnest the renovation of JSAE for its long-term development based on the orientation set by this committee, and I also hope that you will continue to support us as you have done until now.

In closing, I would like to end my greetings for the new year by extending my wishes for the greater health and prosperity of our members and their families.

Osaka University Captures Four Kinds of DNA Bases by Scanning Tunnel Microscope

95FE0399 Tokyo KIKKAN KOGYO SHIMBUN in Japanese 20 Mar 95 p 1

[FBIS Translated Text]

Tomoji Kawai et al. of the Institute of Scientific and Industrial Research, Osaka University have been successful in capturing the shapes of the four bases, adenine, etc., that form genes (deoxyribonucleic acid (DNA)) using a scanning tunnel microscope (STM). The width of adenine and guanine are 1/1,000,000mm (ten Angstroms), and adenine is heart shaped; thymine and cytosine are six Angstroms wide and are round, and it was ascertained that all of them have flat, rice cake-like shapes. After this, effort will be put into capturing the chains. Since, if this is possible, it will open of the path for selectively rearranging bases, these results are attracting attention as something that will make for great progress in gene manipulation.

The four bases are all basic components of DNA and ribonucleic acid (RNA), and adenine and guanine are purine bases, while thymine and cytosine are pyrimidine bases. Adenine is heart shaped with a diameter of ten Angstroms and a height of five Angstroms. The diameter of guanine is the same as adenine, and its height is two Angstroms. Adenine, which has nitrogen attached to it was commonly taller than guanine, which has oxygen attached to it. Thymine is a sphere shape with a diameter of six Angstroms, and cytosine has a diameter of six Angstroms and a height of two angstroms.

In genetic engineering, in which DNA, the body of genes, is cut and connected using a special oxygen, capturing the shape of these bases, which are the basic components of nucleic acids, has been an important problem.

Using the property that a tunnel current flows when a small metal probe approaches the surface of substance, Kawai et al. produced an STM in their laboratory, and they have been working on capturing the structure of the bases.

The strontium titanate substrate on which the samples were placed this time was heat treated to increase the flatness of the surface after it had been mechanically polished, and along with this, the resolution of the STM itself was increased, so they were able to capture the four bases. Tungsten was used for the probe.

The laboratory was successful under conditions of two bases being included, and it plans to work on capturing a mixture of all four bases on the one hand and viewing them in DNA without breaking it down on the other.

Reporting on Real World Computing Project

MITI To Develop Four-Dimensional Computer

95FE0254A Tokyo NIHON KOGYO SHIMBUN in Japanese 26 Jan 95 p 3

[FBIS Translated Text]

Optical Wiring and Individual MPU With Added Communications Functions: Goal is Realization of "Human" Processing

An outline for a "four-dimensional computer" that the Ministry of International Trade and Industry (MITI) will begin building during 1995 was made public on the 25th. This is a super-parallel computer having 1,024 individual microprocessors (MPU) with combined arithmetic and communications functions, and the world's first optical wiring will be mounted onto the core central operations structure. The Real World Computing Program (RWCP; NEC President Tadahiro Sekimoto, Director) has been commissioned to research and develop the computer through a 10-year project that began in 1992. MITI plans to utilize the completed four-dimensional computer to accelerate research and development on human-like flexible information processing functions.

By the end of March, the RWCP will develop an MPU meant exclusively for a super-parallel computer with arithmetic processing and high speed communications functions. Construction of the computer itself will begin after April. 604 MPUs will be built into a rectangular parallelepiped 1.5 meters long, 1 meter wide, and 0.8 meters deep; the computer will be operated by linking two of these together.

In order to carry out high speed transmission of data between the microprocessors, optical wiring will be employed in one part of the central operations structure. This will be the world's first mounting test for optical wiring. The mounting will be expanded as test results are checked, and ... would like to shift all wiring to optical communications in the future.

Software development is continuing at the same time. In addition to the basics such as the operating system (OS) and programming language, scientists are trying to develop a way to integrate information so that it can be understood by combining characters and pictures, much the way a person would read a comic book.

As improvements are made in the four-dimensional computer itself, the number of MPU will gradually increase as well. Ultimately, the system will be expanded to one in which 1 million MPUs are theoretically possible. MITI is promoting a "Joint Optoelectronics Project" with the United States as the RWCP's optical technology link; the U.S. Department of Commerce is directing its attention to the results of optical technology that Japan has taken on first.

Definition: Four-Dimensional Computer

The "four-dimensional computer" is a project that aims to realize information processing functions with nearly human flexibility, by merging super-parallel computer technology with various types of advanced technologies such as optical technology, neural networks, and fuzzy logic. The formal name is the "Real World Computing Program". The program is engaged in researching high level recognition functions and problem solving functions, and got its popular name, "four-dimensional computer", because another goal is recognition of animation that changes over time. The RWCP was established in 1992, based on the Research Association for Mining and Manufacturing. 70 billion yen over 10 years has been allocated for research and development costs. The computer itself is being developed in the next fiscal year, which is the program's fourth year.

MITI Firms Up Information Theory for RWCP

95FE0254B Tokyo NIHON KEIZAI SHIMBUN in Japanese 7 Feb 95 p 15

[FBIS Translated Text]

Both "Ambiguity" and "Learning" Included

With the goal of building a computer that can think with nearly human flexibility, the information theory that is the foundation for the Real World Computing Program (RWCP) started by the Ministry of International Trade and Industry (MITI) in 1993 has been determined. The new theory is known as "Bayesian inference within metaprobable space", in which a computer can be taught ambiguous information. Until now, the RWCP had not yet settled on this core information theory, but concrete research and development will now get under way.

The new theory was proposed by Nobuyuki Otsu, Intelligence Information Section Chief of the Agency of Industrial Science and Technology's Electrotechnical Lab. It is a type of statistical theory, but it encompasses fuzzy reasoning that deals with ambiguous information as well as neuromodels for realizing learning functions. It was chosen as the program's core theory because it covers two essential components of the RWCP: "ambiguity" and "learning".

The subject of the RWCP is an issue that was left out of the Fifth-Generation Computer project, which was in effect during the 10 years since 1982. A Fifth-Generation computer attempted to come close to the human method of processing information, based on a prescribed system of logic. However, it was found through later research that "intuition" was more important than "logic" in human information processing.

In order to bring about the learning function and achieve the goal of "flexible information processing", the program is built on three pillars: creation of an information theory that causes intuitive information processing; basic design of a computer that runs programs based on this theory; and establishment of high speed element

manufacturing technology, in order to operate the new type of computer designed. Within these goals, some aspects have been determined; the computer's basic design will employ super-parallel processing, and three-dimensional optoelectronic composite elements are the targeted elements. But the most basic pillar, an information theory, was not clearly defined before now. The new theory proposed by Section Chief Otsu will fill the hole in this research project.

Bayesian inference, which is the foundation of the theory, is known as a basic principle for expressing the probability of an event. By using Bayesian inference, the probability that a group having certain tendencies is selected can be derived by an equation, by providing established conditions. The conditions may be "ambiguous". Section Chief Otsu discovered that Bayesian inference can be used as a theory to represent fixed concepts that transcend simple probability, and calls this metaprobable space. By using this theory, one can deal with "human-like" concepts that cannot be handled in the realm of logic, such as "neither good nor bad".

Professor Toshikazu Amari of Tokyo University's Faculty of Engineering, who chairs the RWC program's Evaluation Promotion Committee, says that "the new theory has a wide number of uses, and is easily transplanted to the field of computers. It can become the underpinning for the project."

Commentary on Core Theory Chosen by MITI for RWCP

95FE0254C Tokyo NIKKEI SANGYO SHIMBUN in Japanese 10 Feb 95 p 5

[FBIS Translated Text] A new theory, "Bayesian inference within metaprobable space", has been settled on as the cornerstone of the Real World Computing Program (RWCP) started by the Ministry of International Trade and Industry (MITI) in 1993. This theory will give a research and development core to the RWC program, which has heretofore been preceded by its image of "flexible information processing".

The RWCP aims to apply human-like "intuition" to computers, instead of "logic" sought by the Fifth-Generation Computer development project, which aimed to realize "artificial intelligence". The RWCP has created three-dimensional optoelectronic integrated circuits in order to bring about the complex wiring much like that of the human brain, and is coming up with a blueprint for applying super-parallel processing of information, which is what the brain does. However, debates on the fundamental core information theory that will connect the computer with humans had not been conclusive.

The new theory that determines the core information theory was proposed by Intelligence Information Section Chief Nobuyuki Otsu of the Agency of Industrial Science and Technology's Electrotechnical Lab. It has two of the characteristics that are key points of the RWCP: "flexibility in dealing with ambiguous information" and "ability to learn".

Bayesian inference itself is known as a basic principle of probability. For example, a simple mathematical equation would be "probability that one can assume it is raining under the condition that a person is putting up his umbrella = probability that a person puts up his umbrella when it rains x probability of rain falling ÷ probability that a person will put up his umbrella".

When we consider Bayesian inference as a computer theory, we see that first of all it has the flexibility to process ambiguous information presupposed by the RWC program. Using the above example, a romantic drenched by the spring rain or a woman opening her parasol do not matter. Furthermore, Bayesian inference addresses learning, which is the other pillar of the RWCP. An equation based on Bayesian inference has "experience" or "statistics" on the right side, and inferences for each case on the left side are derived from these. If the numerical statement representing acquired experience is altered, the content of the inference on the left side will be revised.

Up to this point we have described traditional Bayesian inference, but Section Chief Otsu has thought of a Bayesian inference combination. In more concrete terms, an attempt is made to estimate the probability of "rain" or "a gentle wind" occurring under the condition "a person carries an umbrella". Here, an interesting thing happens: the Bayesian inference jumps from its original realm of probability to the "conceptual" realm that encompasses it. Section Chief Otsu calls this realm "inductive probability space" or "metaprobable space". "A, and yet, not A" is an example that suggests just how incomprehensible metaprobable space is. Such a possibility does not exist in the realm of probability, but it is permitted in the realm of metaprobability.

Humans are thought to be the inhabitants of the realm of metaprobability. For example, there is a possibility that a little girl who is asked "do you love your father?" will reply "I can't say that I love him, or that I don't love him." Her answer is completely illogical in terms of the general study of logic, but can be somehow grasped by humans to be a "feeling".

In order for a computer, which is a logical machine, to enter into this realm, its programs must go from linear expression through combinations of linear equations to nonlinear expression. This realm has been difficult to realize with programs that formalize concepts or with predicate logic programs that the Fifth-Generation computer handles.

However, we have come to understand that the nonlinear quality itself is the key for putting human-like "intuition" and "flashes of insight" into a computer. When Otsu's lab at the Electrotechnical Lab asked a computer to solve an example of pattern recognition in a

simple program created by using Bayesian inference in metaprobable space, Euler's formula, which is known in the field of topology, was "discovered". This formula cannot be found by simply continuing to pile on logic; some conceptual conversion is necessary. Because existing computers cannot have "flashes of insight", Euler's formula could not be derived. Bayesian inference could perform the task without difficulty.

The attempt to give nonlinearity to programs has recently become one of the themes in computer science. For example, pattern recognition theory used in voice and character recognition, multivariate analysis, fuzzy reasoning, and neuromodels are giving birth to new theories such as "neurochaos" for opening up the nonlinear realm. One of the reasons given for settling on Bayesian inference as the RWCP's core information theory out of all of these theories is that nonlinear metaprobable space can be attained without special measures. Furthermore, those connected with the RWC program expect a broad range of applications, because the principle itself is simple.

Report on Progress, Future of 5th-Generation Computer Project

95FE0255A Tokyo NIKKEI SANGYO SHIMBUN in Japanese 4-13 Jan 95 pp various

[Article in seven installments]

[4 Jan 95 p 4]

[FBIS Translated Text] **All research and development for the "Fifth-Generation Computer" project will end this March; the project began in 1982 and lasted 13 years, and cost 57 billion yen. The Fifth-Generation programming language "KL1" and the parallel inference computer "PIM" [parallel inference machine] were recently completed; participants are saying that "project goals have been achieved" (Professor Kazuhiro Fuchi of Tokyo University's Faculty of Engineering). What did the Fifth-Generation project, which created a stir worldwide, actually achieve? What issues remain? These questions will be investigated over seven articles.**

1. Logical Language Holds Fate of Project

The Fifth-Generation concept advocated throwing out the computer language created by mathematician John Von Neumann and used up to the present time, and creating another computer system by using a completely new language. In more concrete terms, the project aimed to replace the procedural language represented by "increase X by A number of times, and let this be Y" with a logical language represented by "if A and B, then X". This new language is KL1.

At the same time, a hardware concept was set forth, known as the large-scale parallel computer. Seeing that improvements in the performance of computer elements was limited, the project adopted a parallel strategy that is determined by quantity rather than quality. PIMs have succeeded in 512 parallel processing experiments. Of these two concepts, the parallel strategy was utilized very early in the world of supercomputers, and microprocessors (MPU) for personal computers are forecast for the beginning of the next century. However, PIMs are the only "parallel inference" machines that perform parallel processing with a logical language.

These are the completed Fifth-Generation Computer technologies, but there is no knowing if these technologies will lead 21st century computer science, as participants anticipate, or if they will come to naught without ever playing an active role, like the battleship Yamato. The Fifth-Generation computer's future depends on whether or not the logical language's ease of use is worth discarding the assets of procedural languages used in the past.

The New Generation Computer Technology Development Organization (ICOT), which is the core of the Fifth-Generation project, has developed a variety of software for visually expressing the superiority of the logical language. These include "PIMOS", the world's first operating system written with the logical language and "Quixote", which corresponds to KL1's high level language, as well as software for gene analysis and legal reasoning.

[5 Jan 95 p 5]

2. Parallel Inference Machine Makes Entrance

The world's first parallel inference machine PIM: there is literally nothing like it in the world, even now. Most of the results of the Fifth-Generation project are intangibles, such as software or human resources, but the PIM is the only concrete object that the project will leave behind.

The performance of the PIM at the time it was developed was phenomenal. Its inferential processing ability is 150 cycles per second (150 megaLIPS), which is 100 times that of a large general purpose computer. The memory is several dozen times larger than that of a large general purpose computer, for handling a large information database.

Its biggest hardware feature is that it was built on the premise of parallel processing right from the start. The communication capacity between central processing units (CPU) is extremely high. When 256 CPUs were made to operate in parallel in order to work out theorem proof software, processing speed was more than 200 times faster than that of a single CPU.

In terms of software, the PIM's distinguishing feature is the logical language "KL1", which is the machine language that it uses. Compared to the procedural machine languages that previous computers have used, KL1 is an ultra-high level language much closer to human natural language, which makes the computer much easier for a programmer to use.

ICOT has trial produced five types of PIM, and has developed more than 1,000 CPUs. The representative machines are the PIM/p, in which eight CPUs have a single memory in common, and the PIM/m, in which each CPU has its own memory. These PIM will be leading a "second life" at Tokyo University and Hokuriku Advanced Science and Technology Gakuin University, among other institutions. According to the transfer plan, 192 CPUs will go to Tokyo University and Hokuriku Gakuin University, 128 will be moved to Kyushu University, 64 will go to the National Science Museum, and 32 will go to Kyoto University. The PIMs will be used at each university for PIM research and for teaching. ICOT alumni and participants will be in charge of PIM operation and guidance at each institution.

In the rapidly advancing world of computers, there are no guarantees that PIMs will always be the world's fastest inference machines. ICOT has already developed the newest system that uses logical language with a parallel computer, and has confirmed that its performance is identical to that of a PIM. ICOT Laboratory Chief Toshikazu Uchida says that "the period when the PIM is the world's fastest machine will end in three years", but the merits of its basic design will last forever.

[6 Jan 95 p 4]

3. KL1, Greatest Research Achievement

When asked to name just one result of the Fifth-Generation Computer project, which spanned 13 years, participants all agree that it would be the parallel inference language "KL1". The project was organized for the purpose of inventing KL1, and it would be no exaggeration to say that all research and development, including the parallel inference machine PIM, continued in order to prove the feasibility of KL1.

The basic syntax for the leading computer languages, such as FORTRAN and C, conform to a logic that should be called "Neumann logic", as it was created by Von Neumann. In concrete terms, it uses procedural expressions such as "X=X+1" to mean "add 1 to the variable X, and call this a new variable X". In contrast to this, KL1 employs a completely different logic system called "Horn logic". The program uses logical expressions such as "C, if condition A and condition B are simultaneously satisfied". In Horn logic, the left side of an equation is limited to a single item, and the right side is always connected with AND. Not being able to use NOT and OR is very different from the predicate logic we are deeply familiar with, and constitutes a distinction between it and the procedural languages used up to now.

The logical language KL1 is actually suited to parallel processing. In a procedural language, the value of a variable X is always changing, and when it becomes "X+1" is unclear. When multiple processors are operating in order to perform parallel processing under these conditions, the lag in the timing of data transmission remains as a calculation error. On the other hand, once X is defined in KL1, it does not change. Each processor in a parallel computer can handle every variable regardless of timing. This makes it easy for a programmer to write a parallel program.

The latter half of the Fifth-Generation project produced a number of programs, including an operating system, that uses KL1. The software creators indicate in common the ease in which a program is created, and in particular the reduction in debugging work for correcting programming errors. As with a natural language, habit and traditional advantages are of deep significance to a programming language, and simple comparisons of superiority or inferiority are not taken into account. In order for the number of programmers using KL1 to exceed the number using C, expansion of the peripheral environment, which includes hardware, is a must.

[10 Jan 95 p 5]

4. Two "Assistants" for KL1

If the Fifth-Generation Computer projects' leading "Councillor" is KL1, then the "Chief Aides" developed during the latter half of the project to assist KL1 would be the theorem proof language "MGTP" and the information representation language "Quixote". Both languages are positioned as high level languages that come closer to human language, as compared to KL1 which is the Fifth-Generation machine language. These are structured in exactly the same way high level languages such as PROLOG and C ride on top of the machine language of computers currently in use. These compensate for KL1's drawback, which is that "computer feel" when information is to be expressed.

The theorem proof language MGTP first attracted attention in the field of pure mathematics rather than computer science. The Canadian mathematician Dr. F. Bennett solved a difficult problem that he was not able to undertake by posing a mathematical problem known as the pure group problem. This was in 1992.

After that, American and Australian mathematicians were spurred by Bennett's success and began to prove theorems using MGTP, and are producing results. Up until this point, computers were machines that only performed calculations to the letter, but have progressed to machines that also perform mathematical proofs. MGTP's logic is that "reality is extremely simple" according to one of the developers, Ryuzo Hasegawa, ICOT's Assistant Research Director. He explains as follows.

In contrast to KL1, which has a top-down structure so that "condition A and condition B are necessary in order to satisfy condition C", MGTP was made with a bottom-up structure, so that "if condition A and condition B come about, condition C will come about". NOT and OR logical expressions, which were not permitted with KL1, are allowed in MGTP. MGTP programs written

this way are machine translated into KL1 before execution. At that time, the number of lines in the program expands three to five times. This difference alone makes it easier for programmers.

The compression ratio of other language, the information representation language "Quixote", is more than 10 times that of KL1; however, the incredibly slow speed of calculation, even if a programmer has the parallel inference machine PIM, is a matter of concern.

MGTP and Quixote are the most cutting edge accomplishments of the Fifth-Generation project, which introduced the catch phrase "nearly human computer". ICOT's first Research Director, Kazuhiro Fuchi, introduced both high level languages by saying "this is what the Fifth-Generation project wanted to do."

[11 Jan 95 p 5]

5. Advanced Applications Software, One After Another

Questions from the state law examinations solved in five minutes; analysis of the base sequence of DNA (deoxyribonucleic acid), which takes two weeks, completed in half a day—a batch of advanced applications software has appeared within the new programming environment of parallel inference language, which is what the Fifth-Generation project developed.

The legal reasoning system "HELIC2" [a play on the Japanese word "herikutsu", or "objection for objection's sake"] is the most "Fifth-Generation"-like applications software. Prosecutors and lawyers can imitate the clash of arguments that develop during a trial, and can pull out valid arguments from a database in which precedents and doctrines were previously entered in order to attack the other side's points of contention. This kind of logical processing is difficult with a conventional system. Far from being "objection for objection's sake", HELIC2 manifests genuine legal reasoning that has convinced even experts.

Take for example, the following: "When A struck B in order to get even, B lost consciousness due to a poorly placed hit. A mistakenly thought B was dead, and ran off with B's briefcase in order to make it look like robbery and murder; A then threw the briefcase into the river." In this incident, which crimes—bodily harm, robbery, larceny, dispossession, destruction of property—can A be charged with? This example was a question on the state law examination for 1988; a mock argument devised with HELIC2 was as follows.

The system in charge of criminal prosecution first cites a certain doctrine, in which "deliberate carrying away of another person's private property is larceny." In opposition to this, the system for the defense concludes that the prosecution's claim of "deliberate" action is weak, and counters with "the action was not deliberate because there was no intent to possess the briefcase", based on another doctrine. The argument progresses towards a balance between the necessary conditions for guilt and counter-arguments centered on various doctrines and the principle of legality. The result "the crimes of assault and destruction of property stand, but the other charges of bodily harm and dispossession do not" was reached. The question, which took a person taking the examination 60 minutes to write up, was solved by a computer in five minutes; the person who prepared the question gave the computer's answer a passing mark.

ICOT has also developed an application program that detects similarities in DNA sequences, which is being provided to researchers in genetics. The University of California has estimated that two weeks of work can be done in half a day if this software is used.

The performance of applications software reflects the programming environment, such as language and support systems. The superiority of the Fifth-Generation programming environment, which created the core language KL1 and the high level language MGTP, has been proven by this batch of applications software.

[12 Jan 95 p 5]

6. Translated Into C and Used With Workstations

The Fifth-Generation project created several high level languages on top of KL1 and developed applications software. However, the PIM was the only computer that could use KL1. It is often said that "without software, a computer is just a box", but one could also say that without hardware, software is just garbage. ICOT developed "KLIC" so that the project's successes would not become garbage.

KLIC translates programs written in KL1 into C. C is well known as the language that runs on powerful operating systems and UNIX. There are many programmers who write in C, and C can be used in most computer systems if the machines are serial processors with a single CPU. Fifth-Generation software can now be used in available workstations.

KL1 just recently became usable in parallel processors as well; the transplanting of systems is more difficult with these. If transplant support software developed by ICOT is used, transplanting can be completed with a 1,300 line program; therefore, KL1 will run on many parallel computers. The way in which KL1 runs in a parallel fashion is undeniably a Fifth-Generation computer in itself.

There are currently 13 types of parallel computers that can handle KL1. Workstation clusters, where workstations are connected with communications circuits, distributed memory computers in which each CPU has its own memory, and common memory computers in which

several CPUs share a single memory, can all handle KL1. *Interconnected workstations are included.*

AP1000 (Fujitsu)

Cenju3 (NEC)

SR2001 (Hitachi)

SparkStation and SparkCenter (Sun Microsystems)

DEC7000 (DEC)

RS6000 and SP2 (IBM)

Paragon (Intel)

CM5 (Thinking Machines)

ATT3600 (AT&T)

An interesting utilization method has come about, due to KLIC being an intermediary between KL1 and C. This a method for making large parallel programs by using the assets of large programs written in C as "parts". C programs were originally meant for serial processing, and creating parallel processing programs by gathering several of these together is extremely difficult. However, if "the parallel processing language KL1 is used as the "glue", we can see that these can easily be made into parallel programs" (Takashi Chikayama, ICOT's No. 1 Research Section Chief). The goal differs a bit from that of the Fifth-Generation project, which is artificial intelligence, but it is a technology in actual use.

ICOT has made KLIC freeware, and has released it on the Internet. 2,300 researchers here and abroad have downloaded it, and it is thought that several times that number have used KLIC. KLIC's mission is not confined to handing over Fifth-Generation culture after the PIM is gone. KLIC carries on its shoulders the expectation that it will increase the number of people exposed to the Fifth-Generation culture, and bring the machines that will follow PIMs to the market.

[13 Jan 95 p 5]

7. Used in Core of RWC Machines (Conclusion)

In the 13 years that the Fifth-Generation project was in effect, new concepts have become prominent in the world of computer science, as represented by neural networks. As a result, the Fifth-Generation computer lies between existing computers and neurocomputers, just as Nagoya is situated between Tokyo and Osaka.

If we look at the program technology of three computers, we can make the following classification. Existing computers have procedural programming, Fifth-Generation machine have logical programming, and neurocomputers do not have programs. Logical programming is certainly more human-like than procedural programming is. However, if we consider the fact that programs do not exist in actual humans, then neurocomputers are the most human-like. However, if we look at the actual record, the relative positions for the three are completely reversed. Procedural computers abound wherever we look, while practical operation of logical programming is limited to computers that can use KLIC, or to PIMs. As for neurocomputers, these have not made it out of the laboratory.

Researchers' forecasts have been in agreement about advances in software and hardware technology and about future computers being more human-like, that is, the progress being made on Fifth-Generation computers and neurocomputers. Opinions differ as to whether the Fifth-Generation's golden age will continue for a reasonable period of time, or whether we have jumped into the "Neuro-Age".

If we calmly analyze the situation the latter opinion appears to prevail. The fields in which logical programs can be run are not as wide-ranging as envisioned when the Fifth-Generation project was inaugurated; for example, the view that natural languages may not be completely written in logic has come about. In addition, the science of complexities as represented by chaos theory, which suggests the emergence of order on top of neural networks (natural genesis), runs contrary to Fifth-Generation work. The Ministry of International Trade and Industry's (MITI) 'Dream Project" has shifted from the Fifth-Generation to the Real World Computing (RWC) program, in which the subject is neurocomputers.

However, we can also view the Fifth-Generation parallel inference machine itself to be the most desired computer form. The computer that the RWC program will probably create will essentially be a computer that "cannot give instructions". If hard work is desired from a computer, it is thought to be necessary to call upon a Fifth-Generation machine for core tasks, even if an RWC machine is used for character recognition and other tasks.

The Fifth-Generation project will end shortly, while opinion is still greatly divided. Will it be like a regional city that the train just passes through on a Tokyo-Osaka run, or will it dominate in the way Oda Nobunaga did, by producing a succession of rulers? The true value of the Fifth-Generation project is not yet known.

Science Foundation To Establish S&T Network

95FE0337A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 12 Jan 95 p 34

[FBIS Translated Text] The non-profit corporation Science and Technology Exchange Foundation (Nagoya City, Naka-Ku, Marunouchi 247, Chairman Eiji Toyoda Chairman, 052-231-6351) plans to establish a "Science and Technology Information Network" which will respond to the multimedia age. To that end, on the 18th of this month they will establish a research group composed of representatives from industry, academia, and the government, which will be to consider issues such as what form this new network should take. Groups such as

Toyota Automotive Industries, the Agency of Industrial Science and Technology's Nagoya Industrial Technology Institute, and the Chubu Economic Alliance will participate in this endeavor, which is targeted at, in the future, distributing information abroad through the internet, which is an international information network.

The Science and Technology Exchange Foundation is the primary activity organization of the "Science and Technology Exchange Center," which Aichi Prefecture is planning to build. International Research exchanges are a big facet of this groups operations, and, as a part of that effort, they are planning to establish an international scientific and technological information network. Under their current concept, they plan to establish a network to connect facilities such as national testing and research organizations, the research facilities of universities and corporations, and science and technology promotion associations, to disseminate information domestically and internationally on the results of research and on the opening of research conferences and symposia.

In order to accomplish this goal, this foundation has decided to establish a research group which will look into finalizing the details of this proposal. This research group will be composed of around 20 members to be selected from business, academia, and the government. Akio Fukumura, a professor at Chuukyo University, has been named as the group's chairman. As for industrial participation in the group, Toyota Motors, Chubu Electric, and NTT have all already decided to participate, and it is expected that information-related industries, such as Fujitsu and NEC, will also participate. From the academic world, besides Professor Fukumura, it is anticipated that information processing specialists from schools such as Nanzan University and Aichi Prefectural University will also participate.

As for governmental participation, groups such as the Agency of Industrial Science and Technology's Nagoya Industrial Technology Institute and the Aichi Prefectural government will join in. Additionally, groups such as the Chubu Economic Alliance and the non-profit corporation Chubu Science and Technology Center have expressed their interest in participating. Moreover, the Chubu Bureau of Trade and Industry also plans to participate in an observer status.

The first meeting of the research group will be opened at 10:00 a.m. on the 18th at the Trade and Industry Hall in Nagoya's Naka-District. Besides holding monthly meetings in the future, they will also, as needed, conduct field trips and experiments in order to determine the feasibility of establishing the network. The foundation plans to conclude its research by the end of March, 1996.

Fujitsu Invests in U.S. Firm for Use-Ware Development

95FE0337B Tokyo NIHON KOGYO SHIMBUN in Japanese 13 Jan 95 p 1

[FBIS Translated Text] Fujitsu has formed a capital and operational tie-up with Corporate Software Incorporated (CSI, Mort Rosenthal Chairman, Boston, Massachusetts), the U.S.'s leading independent use-ware provider. During February, they plan to establish a subsidiary in Tokyo's Minato-District which will provide support for all aspects on the informational upgrade of industry. They will undertake a use-ware operation which will cover guidance and training when personal computers are introduced into a company, consulting, and software support after system introduction. In order to accomplish this, they plan to enter into a series of representative support contracts with the various software houses. This is the first time that a use-ware operation has been started by a major company. For that very reason, it is anticipated that this development will have a major impact on the operational strategies of computer makers, both of hardware and software.

The new subsidiary formed by Fujitsu and CSI will be called "Corporate Software" (tentative name). It will be established in the Roppongi section of Tokyo with Fujitsu providing 60 percent of the capital and CSI 40 percent. Eiichi Hashimoto, the former President of Fujitsu's Nagano System Engineering has been named as the new subsidiary's President. Final details, such as the total amount of capitalization, will be determined before the end of this month.

The services provided by the new company will start with use-ware operations, such as hardware selection advice when personal computers are introduced into a company, training, and consulting, and will also include representative training and support for software packages produced by software houses with which they have a representative service contract. Moreover, they are considering providing, in the future, services through a network, such as remote maintenance, software ordering and delivery, and version upgrading.

In the United States, it is common that companies work to increase the level of their white-collar productivity through the use of electronic mail and data sharing by means of personal computer local-area networks (PC-LAN). It is said that, in such a market, the area of greatest growth is found in the use-ware companies, which have direct contact with user companies.

Great expectations are being placed on use-ware companies, which have knowledge and know-how with regard to both hardware and software, especially in the area of PC-LANs, many of which are composed of interconnected PCs of various types. In such an environment, there are limits to the levels of support which can be provided by the computer makers.

The reason that Fujitsu selected CSI as a partner is that it is the largest independent use-ware provider, and because it has a lot of experience in the providing of sales and support in the U.S. for major software makers, such as Microsoft and Lotus. On the other hand, this partnership met both companies' goals, as CSI was aiming at spreading the support know-how that they had obtained in the United States to the international market.

Use-Ware: In general, use-ware refers to all computer-related services other than hardware and software. Specifically, it covers a broad range of fields, including system design and maintenance, guidance and training connected to the introduction of PCs, and consulting.

CSI: A fast-growing company in America's use-ware industry. It has maintained rapid growth since its founding around 10-years ago and, according to recent data from a U.S. research company, it has nearly 10,000 employees, including operators, and has sales of several hundreds of millions of dollars.

NEC Develops ATM Design, Appraisal System

95FE0337C Tokyo NIKKEI SANGYO SHIMBUN in Japanese 26 Jan 95 p 5

[FBIS Translated Text] NEC has developed a system to design and appraise Asynchronous Transfer Mode (ATM) networks, which is the standard for multimedia communication. When the basic structure of the desired net, such as the point to be connected to or the desired relay switch, is selected from a map displayed on a workstation, the system selects the most efficient method of connection and switching arrangement. They were able to reduce the time that it took to design and evaluate an extensive net, comprised of 362 nodes, from one week, the amount of time that such work took previously when the entire process was done by hand, to around four minutes. This system also has the ability to estimate costs associated with network expansion.

It is generally seen that ATM networks will come into full-scale use starting in 1995. Therefore, NEC is planning to bring their newly-developed system into actual use quickly, so that it can be used for applications such as consulting services.

The NEC system, which is named "Plan Quest," is composed of a workstation and exclusive-use software. The system calculates the communications levels for various factors, such as how the data volumes that will be handled by each node will be changed based on the way that they are connected to the net, and then calculates the most appropriate net structure. The users first inputs into the system parameters such as the network relay points and usage frequency. At the same time, the network's "Layering Structure" is indicated. That is, the user decides whether all of the nodes are going to be used in parallel, or whether certain upper level nodes will be created, with the network branching off from there. Based on that information, the system estimates the amount of data that will relayed from each node and determines the number and types of switches to be established. At the same time, the system also calculates the communication costs.

If certain aspects of the network configuration is changed by the user based on this information, the system can calculate the resulting changes in data volume and communication costs. This allows the user to compare the various results and, ultimately, select the most efficient connection method.

Up until now, this work was done by hand. Therefore, when large nets with a huge number of relay points were designed, the design work took a lot of time, and there was no way to determine whether the designed system was the most efficient one or not.

Given that, if this new system is used, not only will users be able to optimize their current systems, but it will also be possible for them to conceptualize future system expansions and design the optimal network. They confirmed that they could calculate the design and evaluation of a network which contained 362 relay points in four minutes. This is a sample calculation of a concept for a wide LAN which could service all of Japan.

ATM: This is an abbreviation for Asynchronous Transfer Mode, which is a transmission type which is to be used in fiber-optic communications networks which will pass information to designated locations utilizing a number of fiber-optic strands. Under this mode, all of the information that is received for transfer is broken into cells, marked with a sequence header (which designates the recipient), and sent to the recipient node. Its special characteristic is that it processes data at a very high speed and, therefore, it is seen as an indispensable network element in the design of fiber-optic networks which are needed to relay multimedia information, which has a very high data load comprised of images, voice, and data.

Omron Develops Multilingual Software for Internet Use

95FE0337D Tokyo NIKKEI SANGYO SHIMBUN in Japanese 17 Jan 95 p 1

[FBIS Translated Text] Omron has developed software which will allow users to freely exchange information regardless of language. This software, which is targeted at use on the Internet—the world-wide information and communications network—will be available on the market as soon as this spring. As a first step, this single software package will be able to handle English, Japanese, Chinese, and Korean. English has become the "official language" on the Internet and this is hindering its spread into regions outside of Europe and America, such as Asia. Omron has decided to participate in the World Wide Web Consortium (W3C), which is a group which is standardizing the Internet, and is working to have this software adopted as the global standard.

Omron has developed a language entry system designated "FI-Wnn." This single piece of software can handle, at the same time, English, Japanese, Chinese (Mandarin and Cantonese), and Korean. For example, this software will allow companies in Japan, Europe, and America to send information, in Chinese, to customers in China. The data receiver can also analyze information in various languages. This will allow users in Japan to easily receive data from abroad, such as technical information written in other Asian scripts.

Currently, language entry methods vary by country and, therefore, most of the computers in use through our the world are limited to processing information which exists either in their own country's language or in English. Therefore, up until now it has become necessary to depend on English when sending or receiving data over the Internet, which crosses international borders.

In the future, they plan to expand the software so that it will be able to process European languages, Thai, Vietnamese, and Hindu.

This development was undertaken jointly with Omron's Chinese subsidiary, Shanghai Omron Calculator Limited Public Enterprise. Along with including character types which can be used for various languages, the software also searches for the most appropriate character at the point of the "phonetic character (kana) to Chinese character (kanji) conversion." This is especially valuable for languages which are difficult to enter and display, such as Chinese and Korean. The system can also convert connected strings of characters utilizing fuzzy logic which differs from language to language.

They plan to begin selling this software starting this spring for around ¥ 10,000. They are anticipating annual sales after three years of ¥ 5 billion.

W3C, in which Omron will participate, was founded by the Massachusetts Institute of Technology (MIT) and began its activities last October. It is aimed at the standardization of functions, such as ID number management methods and security technologies, with an eye toward the further expansion of the Internet. It is anticipated that information and communications companies, universities, and research organization from around the world—primarily from the United States—will participate. Omron will be the first Japanese participant.

W3C has highly evaluated Omron's track record in area of the development of software for work station use and previously sent a letter requesting their participation. Omron's President, Yoshio Tateishi, has made a statement that it will formally participate in the organization, indicating that it will soon join W3C as a representative. It is thought that they will take the lead in the global standardization of the language processing technology required to deal with the particular issues raised in regions which use Chinese characters. If standardization is achieved, it is thought that this will lead to the rapid spread of the Internet through regions such as Asia.

MITI To Aid Earthquake-Damaged Software Development Firms

95FE0337E Tokyo NIHON KOGYO SHIMBUN in Japanese 14 Feb 95 p 3

[FBIS Translated Text] The Ministry of International Trade and Industry (MITI) has decided to extend aid covering five different areas to software development firms which received damage in the earthquake that hit the Kobe-Osaka area. This aid includes a 2-year extension of debt insurance extended by a MITI affiliate and an extension of the delivery period of commissioned software. This will be recovery aid package which will supplement low-interest financing provided by the national government as well as by the prefectural and local governments to software developers, many of which are mid- and small-sized firms whose operations are highly vulnerable to either the direct or indirect impact resulting from damage received by their customers.

There are about 6,400 software development companies nationwide (according to MITI's survey of the status of special service industries), of which about 700 are located in the Osaka-Kobe area. This aid policy will center around the provision of debt insurance and measures connected to specific program development for companies in the effected region, and will be executed through the Information Processing Promotion Association (IPA), a MITI affiliate.

The five areas covered by this aid policy are as follows:

1. Along with extending the term of debt insurance coverage to 2 years maximum, postponing the payment of debt insurance fees by 1 year.
2. The revision of the development plan and delivery period of specific programs currently under development.
3. The extension by a maximum of 2 years the deadline to pay fees which had been due within 1 year following 19 January. Also, the waiving of any delay penalty fees.
4. The extension of the FY95 public subscription period for special programs by 1 month to 10 April 1995.
5. In light of the earthquake, the extension by one month, up until 31 March, for the gathering of next year's independent information processing industries advancement operations development themes

Software developers do not have to bear a lot of capitol investment, however, their business is greatly effected by bad operating conditions amongst their customers. In the recent major earthquake in Osaka and Kobe, there were many software development firms which suffered, along with damage to their own companies, a contraction of their business activities and a stagnation of fee payments resulting from damage received by their business partners, including major firms and core software development companies.

In addition to the MITI aid, the Japan Information Service Association (JISA), which is an industrial association centered around the major software development companies, is taking aid measures such as providing relief payments to, and waving membership dues from, companies badly damaged in the earthquake.

Meitec To Develop Database for Personal Information on Scientists

95FE0337F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 21 Feb 95 p 3

[FBIS Translated Text] Mietec, a large technical personnel deployment company (Fusuaki Sekiguchi, President), has begun full-scale utilization of a database to manage personal information on all of its 3,600 technical personnel. Primary use of this database is connected to the shifting of personnel from one area to another and the determining of benefits, such as bonuses. Furthermore, the company plans to use this database in a wide variety of applications, such as a tool to work up estimates when general contracts are concluded. It is unusual that such a large-scale database would be used in the human resources deployment industry.

The database that Mietec has started using was designed to optimize, to the greatest possible extent, the efficiency of the deployment of human resources. It includes the academic and professional history of the technical personnel attached to the company, as well as a record of the content and duration of those individuals' prior assignments within the company. They began data entry and test use of this database during the fall of last year. They have entered 4 months worth of company internal career data into the database, and they are continuing to add new data to the database every month.

Regarding the specific utilization of this database, at present, it is mainly used when personnel are shifted between regions. Because of increasing demand in the Kanto region, they are taking steps such as, using the database, matching the needs of their customers with available technical personnel, and shifting those assets from places such as Osaka and Nagoya. Mietec has also adopted a system under which the bonuses given to their technical personnel are connected to their ability and background. The database is also used in this regard.

Moreover, in the future, they are planning to use this database as an operational tool when contracts are concluded. When personnel is deployed, the fee can be calculated based on a simple "time merit" system, however, for general project awards, the contract amount cannot be determined unless the work type and amount are viewed in a detailed manner. In such a case, based on the accumulated data in the database, the required number of standard technical personnel will be indicated, and the company will be able to move forward with the contract in a profitable manner.

Furthermore, they will be able to keep their technical work force flexible, allowing them to be able to pick up the required technical personnel at the required time, efficiently utilizing their human resources for the company's projects.

NEC To Develop Software in U.S. for PC-98 Series in Japan

95FE0337G Tokyo NIHON KOGYO SHIMBUN in Japanese 22 Feb 95 p 9

[FBIS Translated Text] Next month, NEC plans to open an Original Equipment Manufacturing (OEM) procurement point in San Jose, California, in the United States' Silicon Valley area, for application software and CD-ROM (compact disc, read-only memory) to be used in its main personal computer line, the "PC-98 series." The new operation will be set up in the San Jose office of NEC's U.S. development subsidiary. The parent company will dispatch 2-3 technical personnel to support this effort, convert powerful U.S. products for PC-98 use, and import those products into Japan under the NEC label. They have already received inquiries from around 10 U.S. software producers and they plan to have 30-40 titles ready for sale by the end of 1995. In this way, NEC, which had limited its involvement in the PC sector to hardware, plans to begin full-scale expansion into the software domain.

The OEM procurement point will be set up in the San Jose office of NEC's U.S. development subsidiary, NEC Systems Laboratory (NECSYL, Keiichi Kagiyama, President, Massachusetts). In the near future, they will dispatch technical personnel, who will possess working visas, to this location, research the strong U.S. software makers concentrated in the Silicon Valley area, and conclude contracts to market software produced by these companies under the NEC name.

NEC has, in the past, promoted the conversion of software by setting up the "Developers Support Program" (DSP), under which NEC loaned out PC-98 series computers and provided technical support to software development companies. Up to 300 U.S. software companies, including [AUTODESK], Lotus Development, and Adobi Systems, have registered close to 2,000 pieces of software with DSP, however, none of these firms have undertaken to market the converted software on their own.

Following the establishment of their full-time software operation, the "Personnel Computer Software Office," they began preparations to open a OEM procurement point. NEC announced its new venture plans at last November's PC event, after which they received queries from around 10 software makers which have, up until now, had no marketing route into Japan.

As the first product to be carried under this operation, last October they began selling "98 Presentation Software," which was a version of the U.S. Microsoft Presentation Software, with a few easy to operate tools added to it. They have sold 500 copies of this software this fiscal year. Subsequently, they picked up the pace of the OEM procurement plan, and, they want to move forward with the development of the Personnel Computer Software Office into a profit center, tied to the mass-marketing of the PC-98 series.

They plan to start supplying software which can support machinery and networks as well, starting in April.

Shimadzu Mass Produces Solid-state Blue Laser

95FE0308B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 11 Feb 95 p 1

[FBIS Translated Text] [Kyoto] Shimadzu Seisakusho, Ltd. will commence the first mass production of a solid blue laser in the world. Production will commence at the Atsugi Factory in Kanagawa in September on an annual scale of a few thousand units. It decided to begin mass production after establishing a price of under million yen through cost reductions. For the time being, it aims to replace the demand for argon lasers.

The solid blue laser is expected to serve as the next generation of optical devices, but there have been few examples of its commercialization. Shimadzu will take the lead in commercialization even though it comes from a different area of industry, that of medical and measurement equipment.

The laser which will be mass-produced is a 473 nanometer short wavelength solid-state blue laser "solid state 473". There are two types, a standard type having a 10 milliwatt output and a low noise type with % difference in output stability, and sample shipments have already commenced. Clean rooms and assembly lines have been expanded at the semiconductor manufacturing technical development center at the Atsugi plant, where all steps from diode production, which includes the cutting of wafers and the attachment of electrodes, to laser assembly can be conducted.

The yield has been raised through design ideas implemented in manufacturing procedures. It will start mass-production and commercialization as the industry leader after reaching the prospect of a price level of argon lasers, which is 500,000 to 1 million yen. Making good use of its advantages of small size and long life, it aims at the broad demand for optical sources in high-density storage equipment, micromachining equipment for semiconductors, medical equipment, and analysis/measurement equipment.

The blue laser of this company excites a YAG crystal, the active material, using a near infrared semiconductor laser to radiate 940 nanometer laser light. Short wavelength light of 473 nanometer wavelength could be obtained by inserting a gallium niobate crystal, which is a second harmonic generation (SHG) device. Continuous oscillation of 32 milliwatts, the highest in the world, was achieved at the laboratory level through design ideas applied to an optical coresonator having good mode match between laser light and excitation light, and applied to the design of lenses which focus excited light.

Osaka University Develops CLBO Crystal for Sensing Element

95FE0308C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 1 Feb 95 p 5

[FBIS Translated Text]

Professor Tomotaka Sasaki et al. of Osaka University, College of Engineering, Department of Electrical Engineering, have succeeded in developing a celenium-lithium-borate (CLBO) crystal which converts infrared lasers into ultraviolet lasers. It has high performance which covers the defects of conventional wavelength conversion crystals, including a broad area of short wavelength conversion up to 213 nanometers. Focusing on short wavelength conversion of solid infrared lasers such as neodymium YAG lasers instead of excimer lasers, which have the problem of longevity at present, would be linked to implementation of a fully solid-state ultraviolet laser.

CLBO crystalline growth was achieved by the top seed growth method in which boron oxide, lithium oxide and cesium oxide were mixed at a fixed proportion and heated to a temperature of 850xC. Professor Sasaki discovered that CLBO has the optical characteristic of generating ultraviolet rays upon laser input to CLBO crystals. Moreover, short wavelength of 266 nanometers to 213 nanometers was output in the ultraviolet range. Crystalline growth is also very rapid, and they succeeded in growing ultra-large crystals of 10 square centimeters in ten days. The conversion efficiency of these crystals is in the class of second harmonic generation (SHG) devices, but they have been confirmed to have higher crystalline cutting properties and impact resistance. The wavelength of infrared lasers could be shortened to the ultraviolet range by stacking two or three CLBO devices. In addition, the wavelength conversion efficiency rises as higher-output lasers are input.

A fully solid-state short wavelength laser has been run on a trial basis at every research laboratory at present.

A solid-state neodymium YAG laser using a semiconductor laser as the excitation source is in the infrared oscillation wavelength, but barium or borates, which shorten the wavelength to the ultraviolet wavelength, can achieve a 200 nanometer wavelength. However, the wavelength conversion is obstructed when greater power is input to raise the conversion efficiency, and the problem of laser optical absorption arises.

Furthermore, lithium borate has the defect of inability to output at wavelengths shorter than 300 nanometers, and the crystalline growth is slow. Growth of a large crystal is difficult, which makes it unsuited for commercialization.

However, solidification of an exposure light source for ultra-fine processing equipment becomes possible since a short wavelength ultraviolet laser, which was impossible using lithium and borate, can be generated by combining CLBO with a neodymium YAG laser. Pattern transfer technology at the 0.15 micron level is necessary for the development of one gigabit class ultra LSI, and the practical application of exposure technology based on X rays and ultraviolet lasers is anticipated.

Excimer lasers have been applied practically at present in the ultraviolet range, but problems remain associated with industrial utilization, including use of fluorine gas, short equipment life, and excessive enlargement of equipment. The advantages in terms of life and size would be expanded if it were fully solid-state, and it would be expected to have great advantages in ultra-precise machining, material surface improvement, optical molding, material synthesis in medical applications in addition to micromachining equipment for semiconductors.

NEDO Under Reorganization, Future Implication in Policy

95FE0427A Tokyo ENERUGI FORAMU in Japanese 1 Apr 95 pp 28-31

[FBIS Translated Text]

Private cicadas crying under the authorities' light

The operations of NEDO (New Energy and Industrial Technology Development Organization, Executive Director Hisao Oka), under the jurisdiction of MITI, are still expanding. The government put together the revision results for the special corporation at the cabinet meeting on 24 February; this was because of the incorporation of NEDO absorbing and integrating the Coal-Mine Damage Corporation (Executive Director Masahiro Kotsu) under the same MITI jurisdiction. This fifteen year history of NEDO including this incident is a history of integration after integration.

As a result, its role as an integrated executive organization for the development of new energy and energy conservation, the objective when NEDO was established, is becoming vague; this is feared to be having a bad influence on future new energy and energy conservation development.

Regardless of that, only the MITI OB executive posts continue to increase. New energy development not advancing without private cooperation is in spite of NEDO, established October 1980 with public and private joint investment. In the beginning, over half the director positions were filled with MITI OB when the executive personnel below the executive director were determined in the summer of that year; this has been ridiculed as "private cicadas crying under the authorities' light." And now, of ten directors (one auditor), only two including the Executive Director Oka, sent by Mitsubishi Electric, can be considered purely private citizens. If the Coal-Mine Damage Corporation is integrated, it is certain that the number of directorships filled by government representatives will increase further and NEDO, consisting of public and private joint investment, will become an organization which is almost completely under the MITI umbrella.

Meanwhile, from its establishment, NEDO has been criticized as "nothing but a tunnel organization connecting MITI and private industry with subsidies and commissions;" furthermore, the discontent that "that tunnel impedes traffic and is liable to delay procedures for the assignment of duties to private business" is high among the commissioned businesses. "For whose purpose" was NEDO originally a corporation? NEDO being a toy of the MITI bureaucracy was highlighted yet again with this administrative reform.

Concerning NEDO, the revision results put together at a cabinet meeting on this same day point to "the emphasis of the allocation of the authorized strength and the organization into new energy-related divisions, the necessity and importance of which are increasing, along with contriving the simplification and abbreviation of procedures for commissioning private businesses, from the perspective of performing multiple diverse operations efficiently and rationally."

Timely opportunity for integration with the Mine Damage Corporation

The revision results for special corporations set forth on 24 February as the first bomb of administrative reform of the government are the abolition of one research institute and the integration of 20 corporations. The integration of NEDO and the Coal-Mine Damage Corporation is one of those, but MITI originally was motivated to abolish the mine damage corporation concurrent with having the completion of coal mine damage processing operations by the start of the next century. Therefore, this issue of revising special corporations is emerging on a government basis and the integration of the mine damage corporation into NEDO has reached the stage of advancing smoothly. This is a timely opportunity.

The Coal-Mine Damage Corporation is responsible for the recovery operations and loans for indemnifications for mine damage produced in the extraction of coal domestically, but the mine damage processing must be completed by the beginning of the next century. The legal time limit of mine damage recovery was extended ten years to 2001 with the revision of the Second Mine Damage Act (Provisional measures for coal mine damage reparations, Provisional coal mine damage recovery act) of March 1992; and in the Mine Damage Recovery Long Term Plan published February 1992, the amount of remaining mine damage mainly in the Kyushu areas such as Fukuoka Prefecture is ¥390 billion by the 1992 original cost. Therefore, it is obligatory that all mine damage processing being completed by 2001.

However, although the increase of the amount remaining, like the amount of recovery work, is unavoidable for the next several years, this organization is gradually decreasing the number of workers by not filling openings and currently there are fewer than 400 workers.

On the other hand, besides new energy and energy conservation development, NEDO operations are work concerning this integration and coal mine industry structure regulation operations which are related directly and indirectly. Loans of money for management improvement investment, following domestic coal mine structural regulation (reduced in stages) many times in the past, to coal businesses and mine damage processing by NEDO itself are performed in these operations. However, the personnel in these operations are being reduced as well from 190 at the time NEDO was established in 1980 to the current 130 (NEDO currently has a total of 855 workers).

It can be expected that the effects of the personnel rotation of the mine damage corporation, which has an increasing amount of operations over the next several years, can be made smooth with the integration. Also the employees of this organization, who have an average age

of 45, will be 51 in 2001, the year that recovery operations are scheduled to be complete, and will still be able to work; therefore, they can be ensured re-employment while gaining experience from the integration.

As soon as 1997, MITI aims to present proposals for the revision and integration of the act to promote the development and introduction of alternative energy and the Second Mine Damage Act, which is the basic law of both special corporations, in the National Diet next year.

However, that. The forward looking stance of NEDO as the organization for alternative energy development is not felt in this integration of both special corporations. Whether the coal mine industry structure regulation operations which are from the time of the establishment of NEDO or the mine damage recovery operations concerned here, these are countermeasures for the post processing of coal because this is the expansion of operations with a so-called backward looking policy.

Furthermore, in relation to losing sight of the consciousness of the original objectives of NEDO, it is feared that will bring about a drop in the morale for new energy and energy conservation development.

Fate of vague character

To begin with, the history of NEDO was a history of integration followed by integration.

NEDO was established with the name of "New Energy and Technology Research and Development Organization" (old name) in October 1980. After the second oil crisis in 1979, MITI decided that it was necessary to have a special corporation with public and private investment to comprehensively perform operations such as promoting the development of new and energy conserving technologies such as solar, coal (liquidized, gasified), hydrogen, geothermal energy, and fuel cells, the development of domestic geothermal resources, and the development of foreign coal resources; in MITI's initial concept, the plan was to establish it as limited to only these objectives.

However, the Earth-Light Clinic started from the following year, 1981, and public opinion was against the establishment of new special corporations at that time in 1980; instead of the Ministry of Finance and Administrative Management Agency (presently the Management and Coordination Agency) deciding upon the establishment of NEDO, they decided to destroy one special corporation under MITI jurisdiction. This is what is called "scrap and build."

In response to this, MITI abolished the Coal Mining Industry Rationalization corporation and approved the establishment of NEDO in a form to inherit those operations. From the beginning, the objectives of NEDO were flimsy.

The work of the rationalization corporation looks backward and aims for domestic coal mine reduction measures such as operations to furnish grants to promote coal mine regulation to advance smoothly the modernization and adjustment of inefficient coal mines in Japan; the original objective of establishing NEDO, new energy development for the future, became too extraneous. If we dare to give the reason for integration, one of the objectives of establishing NEDO was operations for coal liquefaction and coal gasification project development and overseas coal resource development and it can be said that both special corporations are performing operations concerned with "coal." On one hand, there are rear looking coal policies and on the other hand, there are forward looking coal policies; the characters of both operations are total opposites; and it is not an exaggeration to say that the integration used the one common word "coal."

NEDO was destined for the vagueness of that objective from the start.

Integration of next generation projects, big projects degenerate to "toys"

Afterwards, the production division of industrial alcohol monopoly operations assigned to MITI itself was transferred to NEDO in October 1982. With this, the objective of NEDO became more and more vague. The industrial alcohol production methods include synthesis methods and fermentation methods, production by synthesis methods is through commissioned production to manufacturers by the nation (MITI) and production by fermentation methods is directly performed by the nation (MITI) in state operated plants, but this state operated production division was transferred to NEDO.

The reason for the transfer is that the development and introduction of alcohol at that time was through future petroleum alternative energy development. However, most of the alcohol products produced are raw materials for chemical engineering and were not originally to become alternative energy or new energy. Based on the cabinet determination concerning the administrative reform of December 1979, the transfer from state operations was determined with a look back at the establishment of NEDO, but it is not exaggerating to say that the reason of being through alternative energy development "included calling white black."

Furthermore, the character of NEDO changed greatly and conclusively in October 1988.

This was because NEDO inherited all research and development operations other than those related to new energy and energy conservation of the MITI Agency of Industrial Science and Technology. Originally, NEDO started by receiving subsidies (subsidy rate 100%) from the Sunshine Plan of the AIST for new energy technology development such as solar power generation and coal liquefaction and from the Moonlight Plan of the AIST for energy conservation technology development such as fuel cells and new power cells for power storage, but began to inherit all research projects unrelated to energy from October 1988.

Concretely, the manganese nodule mining system, limited operation robots, comprehensive computer database system, advanced processing system, supersonic transport

propulsion system, and the high speed computing system for science and technology are "Large industrial technology research and development projects" (big projects) given the objective of promoting the improvement of Japan's industrial structure by AIST.

The "Next Generation Industrial Basic Technology R&D Project" (Next Generation Project) for the development of next generation industrial basic technologies having the objective of the development of technology requiring a long period of time for research and development, basic technology having a strong revolutionary character, was also inherited. These are projects using high efficiency polymer separation film material, super environmentally resistant advanced materials, technology using recombinant DNA, and fine ceramics, for example. Research and development projects for an automatic leucocyte separation device, digital hearing aid, and reading and writing instruments for the blind are the same kind of research and development projects for medical instrument technology. Strictly speaking, do these have a relation to new energy, energy conservation, or alternative energy?

Naturally, the word "industry" had to be added to the [Japanese] name of NEDO and it was changed to "New Energy and Industrial Technology Comprehensive Development Organization" with administrative reform. Originally criticized as "too long," the name became still longer; "further development and international contribution of technology development" was the measure given primary emphasis by MITI at that time; NEDO was used for that reason. Originally, MITI was to establish special corporations for the big projects and the next generation projects, but failed in the end. The "bill" for that was sent around to NEDO and gradually NEDO was made a "toy."

The number of non-energy related projects has currently risen to close to 100. The budget for these industrial technology R&D operations is ¥3.7 billion (1994). By the way, the budget for that year was ¥7.87 billion for new energy and energy conservation development operations, ¥9.85 billion for coal mine industry structure regulation operations, ¥1.65 billion for alcohol production, and ¥23.07 for all NEDO operation planning.

From domestic coal mine adjustment, alcohol production, and biotechnology to electronics-information-communications, aviation-space, and the development of digital hearing aids, NEDO operations cover many areas. That is to say, it takes the form of a special corporation where it is not understood "what is what" with MITI's "opportunism."

To that extent, it is feared that the morale for new energy and energy conservation development which was the original objective of NEDO will drop.

Targets for energy supplied in new forms with reorganization of new energy

	Year	1992	2000		2010	
			Current policy forming case	New policy supplement case	Current policy forming case	New policy supplement case
Reclaimable energy	Solar power generation 10,000 kW (10,000 kl)	(0.04)	9(1)	40(4)	98(10)	460(45)
	Wind power generation 10,000 kW (10,000 kl)	(0.1)	1(0.2)	2(1)	11(2)	15(2)
	Solar heat 10,000 kW	113	169	330	223	822
	Temperature difference energy 10,000 kl	0.6	10	20	29	58
Recycled energy	Waste material power generation 10,000 kW (10,000 kl)	23.2	140(74)	200(106)	200(257)	400(212)
	Trash processing exhaust heat 10,000 kl	3.9	5.5	7	9	14
	Black liquor, obsolete material 10,000 kl	488	505	505	539	539
New usage of traditional energy	Cogeneration (excluding steam turbine) 10,000 kW (10,000 kl)	277(277)	455(435)	542(523)	813(705)	1,002(879)
	Fuel cell* 10,000 kW (10,000 kl)	1(0.2)	11(5.3)	20(10.5)	150(62.0)	220(123)
	Methanol, coal liquefaction 10,000 kl	0	0	0	21	96
	Clean energy cars 10,000 kl	0.3	3	68	31	324
Total	10,000 kl	906	1,203	1,564	1,830	2,991
	Percentage of secondary energy supply	1.5%	2.7%	3.6%	3.7%	6.4%

Note: The cogeneration type of fuel cells is included in the number for cogeneration. However, the numerical value in the total excludes this redundancy. 10,000 kl is crude oil conversion.

Drop in new energy development is the fault of public and private interests

Here is the proof. In the long term energy supply and demand estimate made in June of last year by the Supply and Demand Subcommittee of the General Energy Investigation Group which is an advisory body for MITI, the share and supply amount of new energy in the primary energy supply dropped greatly compared to the previous supply and demand estimate (made June 1990).

For the year 2000, the former estimate was a share 3.0% and supply amount 17.4 million kl (crude oil conversion); however, this time was 2.0% and 12.1 million kl in the new policy supplement case and 1.6% and 9.4 million kl in the current policy forming case, a drop from one half to two thirds in the supply amount. For the year 2010, while the previous estimate was share 5.3% and supply amount 34.6 million, this estimate was 2.1% and 19.1 million kl in the new policy supplement case and 1.7% and 1.5 million kl in the current policy forming case; it dropped greatly from one third to one half.

Moreover, new energy, in the supply and demand estimate, was solar power generation, solar energy using solar heat, wind power generation, power generation with waste material, and exhaust heat from trash processing.

Meanwhile, the share and supply amount of geothermal energy advanced by NEDO are also dropping. In the previous estimate, they were 0.3% and 1.8 million kl for the year 2000, but in this estimate were 0.2% and 1.0 million kl in both the new policy supplement case and the current policy forming case, but this time dropped greatly to 0.6% and 3.8 million kl in both cases.

Also, in the energy supply form goals presented at the same time as this long term energy supply and demand estimate, the dissemination target for the year 2000 for fuel cells for which NEDO promoted the development was 200,000 kW in the new policy forming case and 2.3 million kW in the same case for the year 2010, much lower than in the previous estimate. Fuel cells, for which dissemination is anticipated, are the ace of dispersed cogeneration at the beginning of the 21st century, but this is because long term reliability following continuous operation has struck a technical wall.

Furthermore, liquified coal oil, which was the leading project when NEDO was established, is only estimated to be disseminated to 960,000 kl in combination with methanol in the new policy case in the year 2010.

Since NEDO started, new energy and energy conservation development has been promoted while being infused with a total of ¥ 70 billion of taxes up to now, but the extent of the results is very uncertain. A period where radical preparations such as the narrowing and emphasis of many diverse new energy and energy conservation development projects are necessary is imminent.

In such dangerous circumstances for new energy and energy conservation development, NEDO continues to expand its operations in areas other than energy. Furthermore, there is strong criticism that the operations commissioned from NEDO to private business are lacking in elasticity and pliability and are not working smoothly.

NEDO should lose excess fat in a reexamination of its own operations and return to its starting point as a new energy and energy conservation development organization since its foundation. It must not degenerate to being a "toy" of the MITI bureaucracy at all. The fault of the private sector, an essential part of new energy development which could not stop that, is also heavy. The people are expecting the promotion of new energy and energy conservation development.

Learning Lessons of Post-Cold War Europe

OW1204091195 Tokyo BOEI GIJUTSU JANARU in Japanese Mar 95 pp 2-3

[By Professor Tomohisa Sakanaka of Aoyama Gakuin University]

[FBIS Translated Text] At the top-level meeting of the Conference on Security and Cooperation in Europe (CSCE) held in Budapest in December 1994, it was decided that the conference should be renamed the Organization on Security and Cooperation in Europe (OSCE) to emphasize its conflict prevention and solution functions as a standing organization for security in Europe. However, this was simply what happened on a superficial level. It is said that, behind the scenes, U.S. President Clinton and Russian President Yeltsin had a heated dispute on NATO's "expansion to the east" and that the final communique was decided on only immediately before the closing. A crack began to appear between the United States and Russia, which have been in a honeymoon period since the end of the Cold War.

Since the end of the Cold War, the separation of Europe between East and West was resolved, and Europe has been filled with the hope of establishing a new order. In November 1990, soon after the unification of East and West Germany, the leaders of the United States and all European countries—including Western European counties, the Soviet Union and Eastern European countries—as well as neutral and non-aligned countries gathered in Paris to hold a top-level conference of the CSCE and declare the end of the Cold War, saying that the period of the division of Europe was over. Thinking that a new age had come, an atmosphere of self-congratulation spread throughout Europe.

Since then, Europe has been enhancing the European security system with the target of "the security of Europe by Europe." Europe has been establishing the European security system after the Cold War by activating the Western European Union (WEU), which had been in only nominal existence during the Cold War period, and examining "common diplomacy and defense policies" with the conclusion of the European Union (EU) Treaty.

Simply speaking, Europe has stratified the security system by locating WEU at the core, placing NATO—a union with the United States and Canada—around it, and placing the CSCE—with its 53 counties of the whole of Europe including western, eastern, neutral and non-aligned countries—at the periphery.

In Europe, there is a feeling which can be regarded as European nationalism, a wish to move European security from overdependence on the United States back to Europe itself. Following the end of the Cold War, there has been a noticeable trend of Europe seeking to separate itself from U.S. influence by emphasizing the union of European countries that is the WEU. However, whether WEU or EU, each union is powerless. Neither has any effective measures to take against an ethnic conflict in the former Yugoslavia at the southern extremity of Europe where the Serbs are involved in wanton bloodshed and destruction with the Hitleresque slogan of "ethnic cleansing."

Eastern European countries have been looking at this with a sideways glance. These countries have historically been under heavy pressure from Russia. Even as Russia has been democratized, their fear has not changed. The fear of Eastern European countries has been further increased by the Russian suppression of the nationalist conflict in Chechnya and the rise of Slav nationalism, such as that of the rightist Liberal Democratic Party led by Zhirinovskiy on the extreme right. Poland, Hungary, the Czech Republic, and Slovakia in the end have wished to join NATO so that they can be defended from the Russian threat.

The United States has been looking with indifference at the European attempt of achieving independence. If Europe starts to treat NATO lightly, U.S. influence over Europe would be reduced. In addition, if the European security organizations are powerless in regional conflicts, the United States could say, "there is no other way than to maintain NATO." President Clinton showed a willingness to support the expansion of NATO to Eastern Europe, but Russia would not accept this. Even if the Cold War has ended, it is insupportable for Russia to see NATO, with the world's strongest army, arrayed in Poland, Hungary, and other countries neighboring Russia. President Yeltsin took a defiant attitude, saying, "This irritates the national sentiments of Russia; are you still all right"?

The end of the Cold War ended the ideological confrontation between democracy and communism. But this has not put an end to the confrontations between peoples and nations. What is now rising in Europe is the thought that a "geopolitical thinking" based on the "balance of power" of nations will be necessary to maintain the peace in international relations. Even the increased interdependence of economies does not mean that confrontation between nations will disappear. Moreover, even if democratization has advanced in Russia, it does not mean the disappearance of Slav nationalism. Europe talks about independence, but can peace be maintained in Europe with a Western European military force which cannot even suppress ethnic conflicts? In this way, Euro pessimism is being born.

When the Cold War ended, Europe was filled with a feeling of congratulation for the victory of liberty and democracy over communism. Such a sentiment has now cooled in Europe. It seems that there may be severe revenge if one is involved too deeply in temporary phenomena that soon pass by, forgetting basic matters such as the characteristics of peoples and nations. We should not think that history has "ended." Rather, it is to be "repeated" in different forms.

TRDI's Third Research Center Profiled

OW1904093295 Tokyo NIHON KOKU UCHU GAKKAISHI in Japanese Nov 94 pp 651-54

[Article by Haruo Fujimoto, Third Research Center, Technical Research and Development Institute, Japan Defense Agency]

[FBIS Translated Text]

1. Introduction

The Japan Defense Agency's (JDA) Technical Research and Development Institute (TRDI) is the agency responsible for research and development of equipment for the Ground, Maritime, and Air Self-Defense Forces (SDF). The Third Research Center is one of five specialized research centers in TRDI. It handles tasks pertaining to aircraft, related equipment, and guided missiles. Its main work is to do the necessary basic research leading to the invention of future equipment, and to check the performance of and evaluate prototype equipment. Aircraft and guided missiles are extremely important items in the SDF's inventory. The Third Research Center has contributed to the development of many items of equipment. The following is an overview of the Center.

2. Location and history

The Third Research Center is located about two kilometers northeast of Tachikawa Station on the JR Chuo Main Line. It shares a site of 240,000 square meters with three units of the Ground Self-Defense Force (GSDF), four units of the Air Self-Defense Force (ASDF), and one other unit. The site is said to have been formerly occupied by the Imperial Army Veterinarian Materiel Office. In 1951 Camp Tachikawa was established. Subsequently the name was changed to Camp Higashi Tachikawa. In March 1958 the Tachikawa Laboratory, the predecessor of the present research center, was set up. In accordance with the May 1958 revision of the law that created the JDA, the present Third Research Center was established. The incorporation of the Third Division in 1964 and the creation of the Administration Division in 1982 completed the present structure.

3. Structure and Personnel

The Research Center comprises an Administration Division and three technical divisions. The First Division handles aircraft and guided missile fuselages and camouflage. The Second Division deals with aircraft and guided missile propulsion. The Third Division covers subsystems for aircraft and guided missiles.

Of the approximately 200 employees, about 75 percent do technical research. About 10 percent of these are SDF officers seconded from their respective staff offices. The researchers' main areas of specialization are mechanical engineering, aeronautical engineering, and telecommunications engineering. More than 80 percent work in these three fields. More than half of the researchers hold advanced degrees from foreign or domestic graduate schools.

4. Current Operations and Main Facilities

The following is a profile of the current operations and main supporting facilities of each division.

The First Division is composed of seven research branches. Research is now being done in areas such as ways to do technical evaluations of aircraft through combat simulation; airframes for missiles; high performance airframe configurations; unmanned aircraft; and fiber optic control systems. In the area of performance evaluation and testing, tests are being run on stealth and high-performance airframe shapes; combined control airframes; unmanned aircraft recovery technology; and control systems using light information control techniques. Subjects being pursued in connection with research prototypes include a program to evaluate the hypothetical performance of future aircraft; multiple control airframes, combining aerodynamic control and thrust control; shapes of large-scale aircraft that are expected to appear in the future; equipment pertaining to the recovery technology for unmanned VTOL aircraft; and the fabrication of composite materials to strengthen aircraft structures. Facilities supporting these areas of research include a facility for testing structural strength that can conduct tests of both passive strength and fatigue strength on actual aircraft structures, and a low speed wind tunnel used to test the aerodynamic characteristics of aircraft and other airframes. This low speed wind tunnel provides large "sting"-type model support equipment, with parameters set by the wave angle in the measurement section. This system can test even highly maneuverable aircraft.

The Second Division comprises six research branches. In the area of research, its main work at present is on blind-type rocket motors and air turbo ram engines, etc., that will increase protection from fire and flying objects. In performance evaluation and testing, tests are being run on such items as reheating fan engines, ducted rocket engines, miniaturized lightweight parts for the major components of future engines, and thrust deflector nozzles. In research prototypes, work is being done on ducted rocket engines, polymer azide propellant, major components for future engines such as high load miniaturized equipment and high output turbines, and combustion wind tunnel equipment. Facilities supporting this research include a propellant combustion test facility that can closely monitor the combustion phenomena of various propellants, and a turboprop engine test facility. This engine test facility can perform tests at air flow rates of up to 1200 kilograms per second. It is a large-scale facility that can test virtually any aircraft engine, as long as the noise can be tolerated.

The Third Division is composed of eight research branches and two testing branches. Its main research at present is on ways to analyze the guidance capabilities of missiles; long-wave infrared imaging guidance equipment; active laser guidance methods; microwave band multiple guidance equipment; milliwave infrared multiple guidance methods; and superior avionics systems

using stealth technology. In the area of performance evaluation and testing, tests are being done on airframe precision guidance systems, infrared imaging guidance equipment, and milliwave infrared compound detection equipment. In research prototypes, work is proceeding on airframe precision guidance systems, microwave compound electronic scanning antennas, milliwave detection equipment used in compound guidance, and cockpit evaluation equipment. In support of this research we have the world's largest electronic three-axis flight table, equipped with a fighter aircraft's weapons control radar. It has a flight motion environment simulator that can imitate an aircraft's flight motion environment, and a missile simulator to evaluate the guided flight capabilities of electric wave or infrared guided missiles. This missile simulator uses a five-axis flight table to display the rotation and change of direction of the missile and movement of the target. It can simulate all flight conditions of the missile from launch until it strikes the target.

The Third Research Center also assists other organizations. In projects planned by higher-echelon organizations that are directly concerned with the development of equipment, we play an active part in technical evaluations, mainly in the system prototype stage, and in the performance evaluation of completed systems. (The Third Research Center has a central role in the missile launch tests that are conducted every year). Also, the pace of joint research with the United States has recently quickened. Our Center's first such project was the Second Division's ducted rocket engine. The Third Division's milliwave infrared compound seeker is also a candidate, and the necessary preparations are now being made.

5. Community activities

As mentioned above, Camp Higashi Tachikawa, the home of the Third Research Center, is the location of the GSDF's 101st Survey Battalion, the Camp Higashi Tachikawa General Services Unit, the 307th Finance and Accounting Unit, the Tachikawa branch of the ASDF's 1st Supply Depot, the Aviation Medical Laboratory, the Air Safety Control Unit, the ASDF's Chuo Band, and, as a separate unit, the Mitama District Unit of the Tokyo Regional Liaison Bureau. These organizations hold district commanders' meetings and other senior staff meetings about once a month. Once or twice a year they also have tournaments for things like volleyball, softball, and go. Every July an evening festival is held as an opportunity for mingling with outsiders, including local residents. A big stage is put up in the middle of the camp's parade ground, stalls selling food and such are set up around it, and a carnival atmosphere prevails. As the long summer day fades away, the participants' spirits pick up, the sound of folk songs is heard around the grounds, and up on the stage, dancers in bright summer kimono form up in lines to perform traditional dances. I think that this kind of interchange between the co-located organizations and the local residents plays an extremely important role in promoting the smooth functioning of our research activities.

6.6. Conclusion

In the preceding pages I have given you an overview of our organization. I regret that my description is rather dry. Our organization, no exception from other units, is feeling the effect of reductions in staff. The drastic changes in the global military situation are being reflected in places like our budget. This is the very time, however, when the importance of technology must be recognized, and we are working to ensure that it is.

Digital Broadcasting Dispute Revives

95FE0369A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 17 Mar 95 p 11

[FBIS Translated Text] The digital broadcasting debate is heating up. At a meeting called by MPT, the "Future Status of Multimedia Broadcasting Business" was a central topic. A report including a summary of the future digital mobile communication is expected at the end of this month. There seems to be a collision between different opinions with MPT wanting to accelerate practical digital broadcasting, and NHK wanting a digital system only after high vision broadcasting is widely accepted. The focal point for the next move has shifted to the time when the Radio Wave Administration Review Committee will begin to consider this issue.

The report that will be summarized on 29th will likely include the following recommendations:

(1) CS digital broadcasting starting in April, 1996;

(2) Cable TV starting around 1997;

(3) Current analog system switched to digital around year 2000;

(4) BS broadcasting expected to become technically feasible around 1999.

Also it is expected that high definition TV will be briefly mentioned in the report with the recommendation that "the current MUSE be adapted and promoted."

Key Is In Radio Wave Administration Review Committee

The hot topic at the discussion by MPT is how to deal with digital broadcasting after a broadcast satellite (BS) that will succeed the current BS is launched in 1999. As for the four channels that will be launched in 1997, the status quo will be maintained, that is NHK and WOWOW high definition will continue to be broadcast. However, the remaining four channels remain open and it may be that the Radio Wave Administration Review Committee might start discussing a digital system after the discussion report is submitted by MPT.

Mr. Morikawa, head of the engineering department at NHK explained, "it is understood that at the Review Committee meeting that was held in May of 1994, it was decided not to employ a digital system on BSAT's 8 channels. Commercial networks are expected to broadcast high definition signals on the remaining 4 channels. A BS digital system is planned after the year 2007 when 21 giga Hz is realized by a new satellite."

Responding to his statement, MPT insists, "although it is technically difficult, if it is possible, it can be changed." Since the summer of 1994 the office of broadcasting policy has been studying the issue, but it has not reviewed a TBS digital system. "We are just waiting for the results of the Review Committee." But there is the implication that a concrete plan is in the making.

Although NHK announced its mid and long term plans in February noting that ISDB including high definition TV will be recommended, for some reason there was no comment on "21 giga Hz in 2007." MPT, as the key organization stated, "the phrase 21 giga Hz should absolutely be avoided."

Afraid of Total Collision

What NHK is most afraid of is that the digital system will be recognized abruptly at the BS stage by the report from the discussion by MPT. In that sense, the report from the discussion might play the role of a breakwater which will prevent the rush of a big digital wave. Also TV makers are complaining with a firm voice, "finally sales of wide TV are rising. If you change policies so frequently, it might end up in a collision damage lawsuit." One year has passed since Mr. Egawa's statement, and the problem of a digital system is still surprisingly deep and strong.

NTT To Start Digital Image Communication Services Using N-STAR

95FE0369B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 15 Mar 95 p 11

[FBIS Translated Text] NTT is going to initiate digital video communication service using an in-house next generation communication satellite, "N-STAR" in 1997. For this reason, the service will be tested for emergency situations and events within the company, its performance will be studied, and then the commercial market will be pursued. Although NTT's video communication service will transition from the current analog system to digital gradually from the fall of 1994, when N-STAR starts operating, NTT intends to become actively involved in the satellite business. Since digital video communication service using N-STAR can be provided at half the cost of analog, the company is expected to become a major player in the satellite business.

Company Use Starts Next Year

NTT's video communication service is provided two ways: one is using ground equipment such as microwave and ISDN, and other is using JCSAT and communication satellite "CS-3."

For satellite communication, JCSAT I and II are used for emergency broadcasting and events within NTT. CS-3 is used for an auxiliary ground communication network as the telephone service to remote islands, and backup when disasters happen.

However, the satellite is currently analog, the cost is high, and usage is limited. NTT is going to gradually transition from analog to digital starting from this fall, and communication using N-STAR will be digital. By this, not only will the cost be reduced from half to one third compared to the existing analog system, but the in-house satellite will be well utilized, and demand for its use can be further explored.

It is planned that, first of all, by using some of the transponders on N-STAR, service will be provided for emergency and event use within NTT, and this application will be evaluated before commercial service begins in 1997. At present NTT is developing a 6 mega bit co-deck and decoder with an MPEG2 interface that is the international standard for digital color motion pictures. By this summer, an experimental model will be completed, and the model will be used at both portable and fixed earth stations.

Earth stations that can interface with N-STAR will be established at network centers scattered around 50 locations under the umbrella of NTT's long distance communication main business office.

BBCC To Exchange Researchers with German Research Organ for B-ISDN Research

95FE0369C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 14 Mar 95 p 7

[FBIS Translated Text] BBCC announced on the 13th that in order to pursue B-ISDN research, the organization is planning an exchange program with Detebellcom a German concern.

Detabellcom has a 10 percent investment from German Telecom, and the company is engaged in leading edge B-ISDN technology research. For future construction of a global information network (GII), it was decided to exchange research resource personnel. For this reason BBCC is going to send its manager, Mr. Kawano, to Detabellcom, and discuss the possibility of joint research. From this summer, researchers will be exchanged for the long term. In preparation for receiving researchers from Germany, plans for accommodations are now underway.

Convergence of Communications and Broadcasting

95FE0369D Tokyo NIHON KEIZAI SHIMBUN in Japanese 10 Mar 95 p 13

[FBIS Translated Text] The legal barrier that separates the business entities of "communication" and "broadcasting" is beginning to collapse. The main engine of this change is the expansion of communication satellite (CS) service.

Last November there was a little parrying between MPT and CS companies. In response to a request submitted through an association organized by CS companies that specialize in certain programs such as J League, Rock Music, and CNN, that less stringent regulations include 12 items to be considered by MPT, MPT responded by saying "reduce the request to 5 items and submit it again." Although MPT explained "the request is not summarized by the association as whole," it was clear that there was some tension created between government and business.

The most important issue to be considered for the 7 items that were submitted included, "elimination of the division between devices used for communication and broadcasting." Because of advances in technology, new businesses, in which communication and broadcasting are merged, are increasing. For example, telephone services run by CATV businesses, and paging services using FM radio waves. However, in CS, the division of communication and broadcasting is still strictly drawn, and the separation of receivers continues.

The horse race TV program that started last October and gained unexpected popularity belongs to "CS Communication," but the foreign movie channel provided by broadcasting companies such as SHOCHIKU belongs to "CS Broadcasting." Both companies are distributing specialized programs for specific audiences, and the same satellite is used for both. However if a business does not have a CS broadcasting permit from MPT, it is difficult to expand into bigger business operations and to aim at a wider general audience.

If a program is considered under broadcasting regulations, then the legal principle of "political fairness and harmonious order for the general public," that is the equivalent of constitution item No. 9 in the broadcasting business, must be strictly followed. That is a problem because if the business is classified as broadcasting, then programming must be reviewed by the programming committee, and a permit for service charges must be obtained. Of course adult programming and certain political channels are all illegal under the broadcasting law. It is difficult to establish a campaign like "promotional discount during a sale." Top executives at CS TV are complaining that "our business is just like a specialized magazine, and we need more freedom to operate than a regular network." Japan Satellite Systems, which plans a 50 channel broadcasting service using compression technology, has asked MPT to "review some of the broadcasting law." Freedom to establish a political party channel aimed at some specific audience is the basis for this request.

CATV Aiming At Radio Waves

As the era advances, a contradictory gap between reality and legality of business operations is widening, and the same is true for CATV. The Alliance of Japan CATV initiated a study group for the radio wave CATV last September. The concept is to provide line-of-sight subscribers with radio waves rather than cable which is expensive to install. "In Hong Kong the use of radio waves is common. The fee can be reduced and after summer the use of radio waves will be actively pursued." The president of a CATV station backing the study group stated.

"Wall" Found In Other Ministries

However in cable TV broadcasting, CATV categorically belongs to "Cable Electronic Communication Transmission." "If radio waves are used, then it is same as a terrestrial TV station." "Don't forget the underlying reason for a CATV permit," says MPT's official to nail

down the point. At present there is no sign that MPT will take an initiative including the allocation of frequencies.

The Wall Exists In Other Ministries

The notice from the Ministry of Finance regarding a computerized banking system can be cited as an example. The notice is about home banking by which bank transactions can be processed at home. At this point, home banking "must only operate during regular business hours," which obviously diminishes the intended convenience.

A "desirability for senior citizen's home health care using telecommunication with the aid of national level funding," has also been expressed. Ms. Toshiko Kunimitsu, the head of Itabashi Area Senior Citizen's Health and Welfare Public Center, is experimenting with this distance health care service in Itabashi area, and leaked her wish.

Ms. Kunimitsu's experiment is jointly conducted with medical schools such as the Tokyo Medical and Dental School, and there is currently no national funding to support this effort. She points out that "if we must rely on volunteers, then the program will not last for long." However, the Ministry of Health and Welfare that is responsible for the law governing senior citizens' health and welfare merely mentions that "still we haven't decided which direction to take."

Last 8 December, a new law governing foods that the Ministry of Agriculture, Forestry and Fisheries submitted was approved, and it will be in effect this coming fall. The new law allows retailers to sell to home shoppers. This had not previously been possible. However there are some restrictions for wholesalers in each individual prefecture, so that retail home shopping for the entire country is simply not permitted.

As technology advances, it is about time that business laws were reviewed at Kasumigaseki.

NEC Develops Partial Diffraction Grating Semiconductor Laser for Subcarrier Multiplex Transmission

95FE0369E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9 Mar 95 p 5

[FBIS Translated Text] NEC has developed a multiple wavelength diffraction grating semiconductor laser array, and succeeded in an experiment using subcarrier multiplex transmission employing a multiple wavelength batch modulation method. The method sends or receives signals by batch modulation of a multiple wavelength laser. The experiment this time verified that two wavelengths were modulated simultaneously, and the carrier noise ratio (CNR) was doubled. The success of this experiment makes it possible to increase the number of channels with respect to the increase of CNR. If the number of channels remains the same, the transmission distance can be extended 1.5 to 2 times. It proved the possibility of a low cost and high capacity optical communication method for the multimedia era.

The optical source for subcarrier multiplex transmission requires low noise, low distortion, and low cost. NEC developed their own multiple wavelength batch modulation laser integrated with a PC laser and the company succeeded in its basic experiment. The light intensity distribution in the resonator was made flat by depositing the diffraction grating partially in the PC laser, so that the phase shift inconsistency on the terminal surface was controlled. Distortion is evenly distributed, and idling is reduced by a factor of three. Integration became easy, and an oscillation wavelength of 1.3 microns was achieved with the experimental lasers, and 4 PC lasers were integrated. With the four wavelength PC lasers it was verified that the distortion relative to the electrical signal is less than 1/100 thousandth, and multiple modulation distortion is quite small.

In subcarrier multiplex transmission by multiple wavelength batch modulation, signals from multiple lasers are synthesized using the same phase shift, so that the signal is intensified. However the laser noise is not synthesized in relation to the phase shift, and therefore noise will not increase. For this reason there is merit in this technology because CNR is doubled by two wavelength batch modulation, and quadrupled by four wavelength batch modulation.

Using the experimental laser as a light source, two wavelength batch modulation with subcarrier multiplex transmission was investigated, and the experiment verified that CNR was improved by a factor of two. If CNR is improved twice as much, then low cost and high capacity subcarrier multiplex transmission will become easy. If the number of channels remains the same, then transmission distance can be extended from one and half to two times.

The transmission method that NEC succeeded in using is being seen as a possibility for low cost and high capacity systems for video service such as video-on demand (VOD) and cable TV (CATV), as well as mobile communication such as cellular telephone.

NEC Takes Order from Taiwan for Satellite Radio Relay

95FE0369F Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9 Mar 95 p 9

[FBIS Translated Text] NEC has received an order for satellite transponders from the Taiwan National Science & Technology Committee which is part a Taiwanese government organization. The transponders will be placed on an experimental satellite, "ROCSAT-1", that will be launched in the spring of 1998. The amount of the order is about ¥700 million. Since there are no diplomatic relations between Japan and Taiwan, in the past Japanese companies were basically excluded from the government projects. This is the first time for NEC to

receive an order for transponders that employ the latest Ka band technology. The Taiwan Government plans to launch three satellites by 2005, and NEC is expecting strongly from now on that it will have advantage of marketshare in Taiwan.

The ROCSAT project is part of a Taiwanese government plan to enhance the base for its high technology infrastructure including domestic industries and technology. ROCSAT 1 represents the first step in carrying out this project. The satellite will be used for experimental public communication aiming at digital TV and multimedia communication and eventually interfacing with future multimedia technology. The ordered transponders are high frequency between 20 giga and 30 giga Hz using the Ka band. Because of the experimental nature of the use, there is only one channel, but the band width is 27 meg Hz which is equivalent to 1,400 telephone circuits. The satellite body is being ordered from US TRW, and the transponders were ordered from NEC through a subsidiary company of NEC.

NEC opened its business in Taiwan in 1982 with 100 percent investment coming from NEC, and since then it has been selling information devices and mobile terminals. However, because there are no diplomatic relations between the two countries, basically Japanese companies were excluded from trade related to government orders. NEC previously demonstrated good performance in receiving orders for over 100 transponders such as those onboard INTELSAT IV/V, and CS-2 (Sakura 2, 3) used domestically, but the order for the latest Ka band transponders is the first.

In Southeast Asia, Korea and Indonesia, each plan to launch their own communication satellites. NEC believes that the current order from Taiwan will provide an opportunity to become actively involved not only with the ROCSAT project but also with any other Southeast Asian government related satellite projects as well.

TTNet Negotiates With NCC, Long Distance Service Provider

95FE0370A Tokyo NIKKAN KOGYO SHIMBUN in Japanese 9 Mar p 9

[FBIS Translated Text] Soon TTNet plans to start negotiation with the long distance group of NCC, in order to realize high speed frame relay (FR) data communication. TTNet is considering construction of a communication network connected by FR in the Tokyo and Osaka areas with a dedicated line provided by NCC. The company is following the step of NTT, the leader in this field. Because of participation from the regional group of NCC, FR market competition has ignited.

TTNet purchased a FR switching device from Stracom, and has been testing its application in major cities since June of 1994. According to their plan, service is expected to begin following the results of a one-year test.

However, in order to compete with value added network (VAN) providers and NTT, or the regional group of NCC, TTNet has come to the conclusion that an FR network connected by NCCUs regional dedicated lines is indispensable. Soon the company will start negotiation with NCC.

Osaka Media Port (OMP), the Kansai area regional group of NCC, is also conducting FR tests, and if it is connected to TTNet, it will become possible to provide the service between Tokyo and Osaka.

TTNet is going to decide exactly when to begin FR service in coordination with each regional NCC group such as OMP.

VPN Link Starts Next Year

95FE0370B Tokyo NIKKAN KOGYO SHIMBUN in Japanese 8 Mar 95 p 9

[FBIS Translated Text] NTT announced on the 7th that the company has reached a basic agreement with three long distance service groups of NCC for its conditional VPN (Virtual Phone Network). Settlement had been quite difficult. Within the month, a mutual agreement for linking with NTT will be signed. As a result, by April at the earliest, three NCCs including DDI, Japan Telecom, and Japan High Speed Communication will enter the VPN service market that was initiated by NTT in February of 1994.

VPN is a new service that enable corporations to utilize the public phone service as its extension, and consequently phone costs will be drastically reduced. According to the agreement, the access charge within a prefecture using NTT's local network is based on the current base fee of ¥ 14.21 (for three minutes). However since the user fee and access charge have a different cost structure, the company is going to review the fee structure adjusting it along with the access charge that will be established by this fall based on NTTUs business group revenue in 1994. The adjusted fee based on the reviewed access charge will be applied retroactively to the start of VPN service.

The connection fee between prefectures that use NTT's local network and NCC's trunk lines will be doubled (¥ 12.57 for three minutes for the route between prefectures).

NTT foresees "the need of some ¥ 100's of millions for the cost of innovation" in order to improve the new network for mutual linkage. Previously the expense of software and hardware were in the same account, but these two will now be regarded as different expense items. Maintenance costs will be calculated referring to the access charge that will be reviewed, and the fee will be reviewed whenever it is necessary.

NTT and NCC had been negotiating VPN service links for five years, and it was quite difficult to reach this far because of a different set of constraints and ideas that both sides had. Since NCC especially demanded the

same service as NTT as a condition for linking and the same fee structure, the companies could not reach any agreement at all, and at one point they faced a dead end in negotiations. For that reason the Ministry of Posts and Telecommunications for the first time in its history came to the rescue and demanded that NTT open the link .

MITI, MOT to Build High Performance Network System for Kobe Port

95FE0370C Tokyo NIKKAN KOGYO SHIMBUN in Japanese 8 Mar 95 p 1

[FBIS Translated Text] It was obvious on the 7th that ministries affected by the Kobe earthquake have been looking into a "High Performance Network System for Kobe Port." The information network will be installed from customs to the bank. From taking orders to shipping cargos, the entire port activity such as loading and unloading will be managed electronically (EDI), so that the system will enable efficient operation and cost reduction. As part of the industrial restoration plan that will be submitted by Hyogo prefecture and Kobe city in May, this innovative idea surfaced. If the plan is realized, the Kobe port will be the first in the world to have an electronic information system.

Focal Point of Restoration Plan

The network accomplishes international shipping arrangement and management on a one dimensional level by connecting each forwarder at the bay and customs, domestic as well as international traders, shippers, and surface and ground transporters. By using computers, information will be managed, and a huge amount paper work will be eliminated. As a high performance information system for the port, the system generally is referred to as a "Cargo Community System (CCS)."

For the restoration of industries crippled by the Kobe earthquake, rebuilding the Kobe port is the key since the port has 10 percent of the export business. For this reason, MITI, MOT, MOHW, and local governments are working on the restoration plan looking at hardware and software aspects, and they will come up with an overview plan soon.

The Kobe port with a trading volume of ¥7 trillion in international cargo business was facing the need for restructuring even before the quake struck. The port only has two 60 thousand class berths, that is the major international standard. Although the Kobe port was once recognized as an international hub, the port was not keeping up to its name. "Electronification" is aiming at not only restoration after the quake, but restoration of an internationally recognized hub port also.

Some European, U.S., and Asian cities such as Rotterdam, Seattle, and Singapore are leading in EDI and CCS. Although Japan is a major sea port trader, employment of electronic systems is lagging, and forwarders are only partially adopting computer systems.

The Japanese Government plans to install "Sea-NACCS" that manages complex import and export cargo processing with connections between customs and bank. The Kobe port will likely become the model to be followed by others.

Oki Electric Develops Network Control System for Telecommunication Companies

95FE0370D Tokyo NIKKEI SANGYO SHIMBUN in Japanese 8 Mar 95 p 6

[FBIS Translated Text] Oki Electric has developed and is now selling a network management system for communication businesses employing object oriented technology. Oki has already delivered the system to KDD, the company is going to sell the same system domestically to NCC and also to U.S. telephone companies. The system that Oki developed can reduce administrative costs by 20-30 percent compared to existing system. Communication businesses domestically and internationally are facing a price war in the market. In order to increase profit, cost reduction and conservative service are intensifying. Oki is going to increase its software development staff from the current 100 people to 150 people aiming at ¥1.5 billion in sales.

Fifty Percent Increase in Software Development Staff

The new system was developed jointly by Oki's network management software group using TCSI's (in California) object oriented technology. The software objects include task sequences as a major component, and data. The objects are combined from parts, which makes it possible to construct systems with various functions and superior expandability.

It can interface with multi-vendor systems, and can be administered by using a single workstation regardless of maker or type of machines with connectivity of LAN and OPBX within the network. The price is from ¥50 million to ¥200 million.

Traditionally for each system, separate software must be developed. Also, for each different machine, one WS or administrator was needed, and if failure occurs, it took considerable time from detection to recovery in many cases.

The new system is:

(1) efficient in development of complex software;

(2) useful for software reuse.

Operational efficiency was increased from 20 to 30 percent.

Oki shipped the first system that uses new software to KDD. KDD uses it as a core system of "HANDS" which is a total management system for international dedicated lines.

Communication businesses are competing with lower phone charges which threaten their revenue structure.

Lower cost and strong service are indispensable. Oki foresees that the new system will be in demand, and the company plans to develop software according to users' needs. Furthermore, sales will be targeted not only domestically but also for long distance phone companies in the US.

Mitsubishi Group Satellite Communication Co. Applies for International Communication Permit

95FE0370E Tokyo NIKKAN KOGYO SHIMBUN in Japanese 2 Mar 95 p 9

[FBIS Translated Text] The Satellite Communication Company (SCC) of Mitsubishi Satellite Communication Business Group is going to apply within a month to the Ministry of Posts and Telecommunications for a license to become an international communication business company. Using SCC's satellite "Super Bird A, B" it is possible to capture the signal in the parts of Taiwan, and so the company is planning international satellite communication business using Super Bird. Already SCC has completed negotiation with related countries to use the spill over signal for their communication services, and it will be possible if everything goes well that SCC will become an international communication service provider from April.

SCC is entering the final stage of discussion with MPT, and intends to obtain a permit after a hearing before the Electronics Communication Review Board at the end of the month, and it wants to obtain the license as an international communication business on 1 April. Already overseas cable TV companies and broadcasting companies are approaching SCC for provision of international communication services, and SCC is considering broadcasting programs from overseas cable TV stations and video transmission services to TV stations.

The satellite "Super Bird A, B" that SCC owns is a communication satellite for domestic communication and broadcasting (CS TV) use. However, part of the signal beam is captured in Korea and Taiwan, and CS TV's channel 6 that SCC is broadcasting is so popular that the program is aired in Taiwan.

If SCC is formally recognized as an international communication business, a path to provide CATV broadcasting programs to Taiwan will open up, and SCC as a video film service provider will be also possible.

JSAT, competitor of SCC, has just received a permit for international communication service using their current satellite. If SCC succeeds in obtaining a permit, the company will be the fifth after KDD.

SCC is going to launch a satellite in 1997 and is aiming at the satellite market. Also since the occupancy of transponders placed on "Super Bird A, B" is 40 percent empty, by entering the international communication field, operational efficiency of transponders will be increased. SCC expects to see a profit in 1995.

Kowa Develops Prototype MPEG2 Video Decoder System

95FE0370F Tokyo NIKKEI SANGYO SHIMBUN in Japanese 27 Feb 95 p 5

[FBIS Translated Text] Kowa, a medical and electronic equipment maker, has succeeded with an experimental model of a video decoder system that can interface with MPEG2 using a new signal compression and decoding method. The system restores the compressed signal, and operation of the device is just like a VCR. It is possible to playback at both normal and slow speed, and to control each frame. Video image files that are stored on a hard disk can be searched with high speed also. Several electronic makers have been developing competitive video processing system based on MPEG2, but systems including an editing function are quite rare. Kowa is going to commercialize the product for broadcasting use.

The system that Kowa developed as an experimental model has compressed video data stored on a 1 giga capacity hard disk. When the file is read, decoding is processed by a special chip. The video is played back in normal NTSC format. The special chip used is made by a U.S. maker.

During the period of read back from the hard disk to decoding, necessary signal processing for brief stop, slow playback, and frame progression is done by a separate chip.

For example, the same signal is repeatedly processed if a momentary stop is desired. Also in the case of slow playback, playback timing is accomplished with a phase shift. Speed can be continuously varied from normal playback speed to ⅓ faster speed.

Additionally, the company plans to prove high speed playback by employing the method of spacing the signal with a certain interval, and reverse playback function.

The experiment this time proved several operational functions by using 30 varieties of 5 second length of video stored on the hard disk. If the capacity of the hard disk is increased, a practical model will be possible.

Kowa's Electro-Optical Business Group has been developing broadcasting equipment, and plans to market commercial products including a total video system using the compression technique.

Ericson Invests in Yokosuka Research Park for Mobile Communication R&D

95FE0370G Tokyo NIHON KEIZAI SHIMBUN in Japanese 10 Feb 95 p 11

[FBIS Translated Text] Ericson, the major communication device maker in Europe, is going to invest and join the Yokosuka Research Park (YRP) being built by the Japanese private and public sectors as a mobile communication R&D base. The development project will be worked out harmoniously with the cooperation of

already participating and investing companies including US Motorola, and Japanese companies including NTT and NEC, for the development of next generation mobile communication. For digital and analog mobile telephone systems, the U.S., Europe, and Japan are adopting different formats. By bringing major top makers from the U.S., Europe and Japan together at YRP, the possibility to move forward for the establishment of a worldwide standard for the next generation mobile telephone has surfaced.

Ericson is going to invest in the third sector of the Yokosuka Telecom Research Park that is at the core of YRP's R&D center. (President: Mr. Hideo Yasuda, Yokosuka City Mayor, capital investment - ¥2.789 billion). Through Japan Ericson in Japan, the company will invest ¥20 million at the time when the capital investment amount is raised in March.

Japan Motorola that is the 100 percent subsidiary of U.S. Motorola has loaned their executive as the general manager of the YRP's third sector company. That company is supported by a 42 percent investment from the local governments of Yokosuka City, Kanagawa prefecture, and Japan Kaihatsu Bank, as well as several other major communication concerns such as Oki, Hitachi, Matsushita, Sony, and Japan Telecom.

Ericson is headquartered in Sweden, and is a leading European communication equipment maker. The company has 40 percent market share of worldwide switching devices for mobile telephone use, and is the central figure for the development of European standard of GSM which may be adopted as a worldwide standard. Along with US Motorola which has a significant presence in analog mobile phone (TACS), Ericson is a leading maker in the mobile phone market. The company has quite strong performance with over ¥50 billion in annual sales including the delivery of a large order to the JR Digital Phone Group, and a joint venture with Toshiba. The president of Japan Ericson is talking about "consideration for establishing an R&D base in Japan" and it is highly likely that the company will open their new R&D base in YRP.

YRP is currently building a worldwide mobile communication R&D base on a site of over 600 thousand square meters next to the NTT Yokosuka R&D Center situated in the suburb of Yokosuka City. Last March excavation of the foundation started, and gradually R&D activity will start from 1997. After completion, it is estimated that about 10 thousands people will be working in the "R&D City." ¥50 billion will be invested, but if equipment investment by each participating company is included, then the total investment amount will be over ¥500 billion.

Already NTT mobile communication network (NTT DOCOMO) has decided to build an R&D Center on the site by investing ¥20 billion, and several domestic makers are also considering similar plans.

Next generation mobile telephone (FPLMTS) "twenty first century version" of mobile phone will move from analog to a digital system . The performance will be equivalent to ISDN in data and video transmission, which will make it possible to send and receive with high speed and, also to have the characteristic of a "boarderless terminal" by complying with a worldwide standard. Currently standardization issues are being studied by ITU, and the decision on (1) allocating the common frequency for each country; (2) using ground and satellite station while broadcasting - is being finalized.

Aiming at ITU's standardization, each major communication business and maker will adopt ITU's specifications based on the existing digital mobile phones. The digital method currently is divided into 4 groups - European method c[illegible]opted mainly by Ericson, PDC adopted b[illegible] other methods adopted by US. However [illegible] be employed by Japan.

If communication business and makers in US, Europe, and Japan can work jointly in YRP, then the next generation mobile phone business will have a good impact on companies in Japan, and worldwide standardization will be pushed hard at the corporate level.

Foreign Investment Sign of Demand in Asia

Ericson's move in opening its R&D center in Japan symbolizes the attack on the demand in the Asian market by European investment. On the other hand, Japanese communication equipment makers are still strongly relying on NTT. In the field of mobile communication, the power of European and U.S. companies like Ericson is increasing, and if Japanese companies are stimulated by YRP, it may be possible to improve the situation in Japan.

Recently an ill feeling toward MPT is increasing among communication equipment makers. One top executive of a major company is annoyed and complaining, "What is MPT thinking? They are bullies."

Since last fall MPT started to switch the direction of policy from protection of the business in PHS, mobile phone, and domestic phone market, to consumer profit. The fee structure has a wide range and MPT is getting a lot of blame.

As a result, there is increasing pressure for makers to decrease their prices. Makers' dissatisfaction with MPT reflects their concern over destruction of the profit structure.

However looking at "friendly relations," business must rely on NTT which has overwhelming power in the telecommunication market. While companies have a luke warm relation with NTT, if this reliance is not improved, the strength needed to fight back in foreign markets will be lost.

One order from NTT amounts to a large sum, which is quite attractive for business. However switching product devices developed jointly with NTT must have approval from NTT, if a maker wants to sell them outside of NTT. After all, it is possible that in order to aim at the market outside of NTT, makers will have to tolerate the use of foreign technology, that will become the only remaining possibility.

Standardization will be accelerated by foreign investment in YRP. However if there is one common place to wrestle for U.S., Europe, and Japan, then Japan will definitely be behind unless the situation of Japanese makers is improved. Therefore how Japanese makers will take advantage of this favorable opportunity is a major topic of concern for them.

Corporate Executive on Intelligence, Defense Technology

OW1204084695 Tokyo BOEI GIJUTSU JANARU in Japanese Mar 95 pp 62-63

["Article" by Seiyu Mori, corporate adviser, Japan Steel Works, Ltd]

[FBIS Translated Text] I have heard that various events are planned in 1995 commemorating the 50th anniversary of the end of World War II. Among them, those which have been reported widely since 1994 are two events in the United States. One is the topic of the exhibition in the Smithsonian Museum of the B-29 bomber Enola Gay which dropped the world's first atomic bomb, and the other is the "mushroom cloud" commemorative stamp of the U.S. Postal Service.

There were two things which surprised me when I stayed in the United States. One is that, when I visited the Military Academy at West Point, I saw Japan's declaration of war and surrender documents in a prominent position near the entrance of the memorial hall. I was surprised all the more because the Japan-US relationship was going at its best at that time. I had a perplexed feeling, thinking that they should not be exhibited at such a time and at the same time that it is natural to exhibit these as historical facts. Public opinion surveys have made it clear that there is a big difference in the friendly feelings between Japan and the United States, and I have heard that Japan is always included in the enemy countries enumerated in the United States, with either a high or low ranking. I think this, together with the above scene, clearly shows the difference in the ways of thinking between Japan and the United States. Another scene which surprised me was in the Aberdeen Proving Grounds, a U.S. Army weapons testing range. Tanks and so on of major countries are arranged on both sides of the roads. The exhibition hall has a collection of Japanese small arms already dispersed and lost in Japan. In a corner of the test range, a new model tank of the Soviet Union, which was the principle adversary of the Cold War was hidden under a cover.

Weapons hide a concentration of software aspects, including the way of recognition by the country possessing them toward adversary countries (in a wide sense including strategy and tactics) and design concepts based on the recognition, and the hardware aspects including the capabilities of the country's industry and the weapons themselves.

Even if the change of the Soviet Union into Russia changes the institutions and the "will" based on them, the "capabilities" based on weapons and equipment do not change easily. Actually, most of the weapons with which the Russians were equipped still exist, and the R&D is an extension of the past.

At the present, the decline of the Cold War structure started the period of new country building for all countries. It is the age in which weapons which have been covered under a secret veil are sold as bargains. It is most important and indispensable to buy some of them for analysis and evaluation.

Today is an age flooded with intelligence, and it is said that nearly 90 percent of the desired information can be obtained though published papers and journals. Even when the MIG 25 arrived at Hakodate, the majority of intelligence had reportedly been already acquired. Then why all the fierce scrambling by Japan, the United States, and the Soviet Union? It was to get the "10 percent" of intelligence related to the organization, operation and details of the weapons which had been covered under the veil.

Once something has started, collecting intelligence on it becomes extremely difficult, next to impossible. Sparing force in such an attempt degrades the concentration of war potential, and a strict warning should be given against such an attempt. If "to know the adversary" is the basis of everything, there is no other time than the present. Whether Japan takes the road of Carthage or the road of Rome depends on what we do now.

Article Views FSX Rollout Ceremony

OW0704154195 Tokyo BOEI GIJUTSU JANARU in Japanese Feb 95 p 62

[FBIS Translated Text] Development of the Air Self-Defense Force's (ASDF's) next generation fighter support aircraft (FSX) began in 1988 with the exchange of documents between Japan and the United States, and the conclusion of a Memorandum of Understanding (MOU). The first prototype (fuselage no. 001) was recently completed, and the rollout ceremony was held on 12 January 1995 at Mitsubishi Heavy Industry's (MHI) Komaki plant (Tomiyama-cho, Aichi prefecture), where it was built.

At 10:30 that morning, there was a press conference for about 100 newsmen crowded into the plant conference room, with opening remarks by (Technical Research and Development Institute (TRDI) Technical Development Officer Matsumoto (for aircraft). That was followed by a detailed briefing by Director Ozaki of the FSX Development Office, and a lively question and answer period.

The aircraft was shown to the news corps at 11:00 AM in hangar 4, and faced a barrage of simultaneous camera flashes.

The atmosphere became solemn at 11:30, when the rollout ceremony was held with some 480 people in attendance, including Director-General Tamazawa and others of the Defense Agency, officials of MHI, and officials from the U.S. embassy.

Opening remarks were followed by the national anthem and a religious ceremony, after which President Aikawa of MHI, the manufacturer, gave his remarks: "On the occasion of the completion of the first prototype today, I wish to express my deep appreciation for the great

cooperation of the Defense Agency and all others involved. I feel a great sense of responsibility in being allowed to take part in this work."

The next statement was from Director-General Tamazawa: "The FSX was completed by fusing excellent Japanese technology onto the base of the excellent U.S. fighter, the F-16C. This has also firmed up the joint relationship of Japan and the United States. On behalf of the Defense Agency, I am deeply grateful to all who assisted in development." There were also words of congratulation from Rust Deming, deputy chief of mission of the U.S. embassy, speaking for the U.S. Government.

Then the tape was cut, a tractor slowly pulled the FSX out of the hangar, and the ceremony was completed.

Development of the FSX included the following steps:

—October 1987: decision to begin development;

—November 1988: exchange of documents and MOU setting framework of development plan;

—1989: Defense Agency contract with MHI;

—June 1992: basic design completed;

—January 1993: assembly of first prototype begun;

—January 1995: assembly completed; and

—Summer 1995: first flight.

The advanced technology incorporated during development includes the co-cured composite structure of the wing, adoption of electromagnetic wave absorbing material on the leading edge of the wing, strengthened wind resistance, active phased-array radar, the mission computer, inertial standard navigation equipment, an integrated electronic warfare system, an enhanced propulsion engine, and more.

In addition to MHI, the main contractor, manufacture of the prototype involved Lockheed Ft. Worth, Kawasaki Heavy Industries, and Fuji Heavy Industries as cooperating companies.

Japan Defense Agency's Technical Research and Development Institute

95FE0325A Tokyo NIKKEI SANGYO SHIMBUN in Japanese 14-16 Feb 95 pp various

[Article in three installments by Shigehiko Nakajima]

[15 Feb 95 p 5]

Part I. Support for Basic Research

From disposable hand warmers to missiles and fighter planes, the Japan Defense Agency's Technical Research and Development Institute (TRDI) has devised a wide variety of defense equipment. The development focus has been on so-called frontal equipment, such as tanks, fighter planes, and escort ships. Judging from budget allocations, it appears that this inclination will not be changing. However, if one looks at the structure recently set forth and plans for new equipment, it becomes clear that TRDI has begun to emphasize basic research from a long-term perspective.

1. Priority on Frontal Equipment Development

"TRDI is primarily a development organization; isn't that why it is weak in basic research?" This sentiment previously came from outside the organization. There is also the opinion within TRDI that "copying American models and simply riding on American efforts has been going on too long" (Mitsumasa Masutani, TRDI's No. 2 Laboratory Chief).

TRDI's main office is located in Tokyo's Setagaya Ward, and employs approximately 1,200 people. According to the fiscal 1995 government draft budget, TRDI's annual budget is about 150 billion yen. Even if the budgets for all research institutions under the jurisdiction of the Ministry of International Trade and Industry (MITI) and the Science and Technology Agency (STA) are combined, the figure is about 100 billion yen, so the magnitude of TRDI's budget is striking.

The organization is split into two parts. One division consists of the No. 1 through No. 5 laboratories for basic research, with about 600 research workers; of these, approximately 100 have a PhD.

Summary of Laboratories under TRDI's Jurisdiction

Name	Location	Primary Subjects for Research
No. 1	Meguro Ward, Tokyo	firearms, bulletproof materials, human engineering, chemical protection
No. 2	Setagaya Ward, Tokyo	information communications, computers, radio and optical probes
No. 3	Tachikawa, Tokyo	aircraft, jet engines, rockets
No. 4	Sagamihara, Kanagawa Prefecture	vehicles, vehicle-mounted machinery
No. 5	Yokosuka, Kanagawa Prefecture	underwater weapons, sonic probes

The other division is known as the technical development organization for developing weapons on an experimental basis. There are four departments: land, ship, aircraft, and guided weapons (such as missiles); most of the nearly 300 members of TRDI's uniformed company (Self Defense Force officials) belong to these departments. The "development" division is the one that is highlighted by outsiders, and with the exception of personnel expenses, the development division accounts for 80% of the budget.

There was no division for experimental production when TRDI was originally started as the National Security Board in 1952, and all trial manufacture of weapons was commissioned to firms engaged in heavy industry. The role of technical development officials was supervision of firms [engaged in trial manufacture], and ensuring that the experimental products reflected the suggestions of actual fighter units. It might be said that a characteristic of TRDI is the emphasis on industrial accumulation of weapons manufacturing technology as a result of the accumulation of basic technology within TRDI.

2. Moving Away From American Copies

The decision to make the provision of frontal equipment its foremost operational policy is rooted in TRDI history. TRDI Director Mahiro Ota reflects on the past and explains "the 1950s and early 60s was the era of American copies, while the next 10 years was a period in which accumulated technology was put to practical use. The late 70s through the mid 80s was a period in which TRDI was conscious of improved private technical know-how, and developed equipment (weapons) suited for Japanese territory." And the last 10 years has been "a period of continued development, with TRDI even more conscious of private sector high technology, electronics being a representative example" (Director Ota).

An emphasis on public sector technology goes without saying. Of the equipment developed in Japan, which does not have strategic weapons like nuclear arms, "70-80% are items that utilize general public technology" (Planning Department Chief Shunji Tanaka). Another reason is that "just like a marathon runner, TRDI couldn't keep up the pace if it had to do all the work independently from the start" (Director Ota).

However, Japan's defense technology "is catching up with the United States, and is becoming a model itself" (Planning Chief Tanaka). Examples include 1990s style tanks, in which automation and reduction of labor was sought, and fighter support planes (FSX). And No. 1 Lab Chief Masutani reflects that research that overemphasizes development "makes for close cooperative ties with private industry, but the short-term way of thinking is a minus in terms of encouraging self-sufficiency in TRDI scientists."

3. New Projects Launched

TRDI has embarked on new projects related to basic research, based on the changes in circumstances outlined above. One of these projects is future research on jet engines. Preparations are continuing on a testing device that will study from the ground the behavior of jet engines in cold, oxygen poor high altitudes above Chitose in Hokkaido.

And in 1995, production will begin on a wind tunnel device that studies aircraft characteristics by creating three types of air flow: subsonic speeds (high speeds below the speed of sound), transition speeds (speeds just above and below the speed of sound), and supersonic speeds. It is believed that this will have an impact on private industry as a base for developing Japanese aircraft technology; in addition, research results may ultimately lead to various "spin offs" for the public sector.

"Flex time" was introduced in the laboratories last spring, and "Special Research Officials" will be established during fiscal 1995. This is a post awarded to researchers with superior achievements; the salary is at the laboratory section chief level but without the managerial duties. TRDI wants these scientists to devote themselves to research, and gives their research expenses priority allocation.

Expansion and improvement of facilities for experiments, and transformation to an organization suited for basic research—how these goals will keep balance with "development" is a big issue, but the Technical Research and Development Institute is starting down a path towards becoming a technical "research" institute, in fact as well as in name.

[15 Feb 95 p 5]

Part II. Japan and U.S. On Equal Terms

From catching up to the United States to joint research with "give and take" between Japan and the U.S. It has been nearly 40 years since the Japan Defense Agency's Technical Research and Development Institute (TRDI) was inaugurated. When Japan, which had received aid from the U.S., established an independent foothold in defense technology, it was natural to begin joint research that could "give" to the U.S. Following the FSX (fighter support plane), joint research on a new type of rocket engine began, and discussions between Japan and the U.S. on new high tech research themes such as missile sensor systems and ceramic engines are continuing.

1. Taking On Original Technology

At TRDI's No. 3 Laboratory in Tachikawa, Tokyo Prefecture, Lab Chief Ronosuke Kubota points to a warehouse-like building far bigger than a gymnasium, and says that "strength tests for a trial manufactured FSX will begin in that building very soon." The forces that each part of the fuselage is subjected to due to its impact with the atmosphere will be reproduced, and any changes to the fuselage will be studied by attaching a number of sensors to the experimental plane. The trial produced FSX will fly over Japan for the first time this summer.

The experimental FSX was completed just before January. It is based on the U.S. F16 fighter plane, but the unified main wing is much lighter than metal wings currently in use, due to a composite using carbon fibers. The plane is also equipped with a new type of radar where, instead of a parabola antenna, small, simple elements are arranged much like the compound eye of a dragonfly. Both of these new technologies originated in Japan.

2. U.S. Asks Japan to "Give"

Initially, there was a strong proposal for independent Japanese development of the FSX. However, FSX development became a joint effort due to strong pressure from the U.S. This is because the U.S. had been closely observing the improvements in Japan's defense technology know-how. From this point on would come a stream of joint research and development issues to be tackled, with both Japan and the U.S. on equal terms. Japan's defense technology is limited to several fields, but has achieved a level on par with the U.S. The United States, which has given defense technology to Japan for a long time, has come to a point where it asks Japan to give.

Since 1992, TRDI's No. 3 Lab has been working on a Japan-U.S. joint research project for a new type of rocket engine known as the ducted rocket engine. This is one kind of solid rocket that generates a thrust by burning solid fuel; the fuel cost is about twice that of current models, but the rocket engine can go much farther with the same amount of fuel carried on board. It would be useful as an engine for anti-aircraft and anti-warship missiles.

The secret is the ignition structure. Structurally, previous solid rockets need more oxygen (oxidizing agent) with the fuel, and discharge gasified fuel while imperfect combustion occurs. In contrast, oxygen is increased in the new engine by taking in oxygen from the outside the way a jet engine does, which completely ignites the fuel. This idea had been previously understood, but never got off the drawing board. Because the quantity of oxygen in the atmosphere varies by altitude, the quantities of fuel discharged and air taken in must be controlled in response to flight altitude, and this type of technology could not be developed. TRDI's research corps opened a path for realizing the new rocket engine by devising a valve structure that changes the amount of solid fuel supplied in response to changes in air pressure, and independently developed a new fuel with characteristics suited to the new ignition structure. The technology is highly valued by the U.S.

Following the FSX and the ducted rocket engine in the fields of aircraft and missiles is the "composite milliwave-infrared seeker", for which joint research is being discussed. A milliwave is an electromagnetic wave several millimeters in wavelength, and the seeker is a system in which a target is picked up and pursued by using milliwaves and infrared rays simultaneously. In order to avoid missile attacks, fighter planes confuse missiles by jamming radio waves, but the seeker will be useful in developing missiles that can withstand jamming.

The key word that the FSX main wing, ducted rocket engine, and milliwave-infrared seeker have in common is "composite", according to Lab Chief Kubota. As a result of aiming for faster, higher, and farther, we are beginning to see the limits in weight reductions for metal wings and improved combustion in rocket engines. Composite technologies have become one way to continue this work. And designs that comprehensively advance research on composite technology are currently being completed through joint Japan-U.S. efforts.

3. Expanded Fields for Joint Research

Joint research projects are not limited to aircraft. Among the projects being discussed by Japan and the U.S. are lighter, fuel efficient ceramic engines for combat vehicles; welding technologies for structural steel with super-high tensile strength, which would be useful in constructing submarines that can withstand submergence at great depths; and closed loop demagnetization technologies for preventing mine assaults by demagnetizing warships.

The start of joint Japan-U.S. research has produced a new generation of TRDI researchers. TRDI is going all out to improve the language skills of newly hired scientists through one-month concentrated study, and study abroad (primarily in the U.S) has been instituted. This is related to inequalities in terms of acquiring technology from the U.S. However, this contrasts with the joint research, in which Japan and the U.S. are on equal terms. TRDI is investing in young scientists in the prime of their development within a new research environment, and is ready to foster new talent on the job.

[16 Feb 95 p 4]

Part III. Emphasis on Preparing for Electronic Warfare

The research and development orientation of the Technical Research and Development Institute (TRDI) can be boiled down to three phrases. The first is "emphasis on basic research", and the second is "joint Japan-U.S. research"; the third would be "conversion from hard to soft subjects for research".

In contrast to "hard" items such as tanks and fighter planes, "soft" means electronic technologies that become the eyes, ears, and nerves for troops. This is represented by the word "C^3I" which is an abbreviation for the English words command, control, and communicate, together with the word information.

1. Polishing Infrared Sensors

At the No. 2 Laboratory in Setagaya Ward, Tokyo, a strange device that looks like a white bald head with giant eyes sits at the window of a building that looks out on a typical Setagaya street. It isn't glass inserted into the

"eyes", but lenses made out of germanium, which allows infrared rays to pass through. "We began by polishing the lenses", states No. 2 Lab Chief Mitsumasa Masutani. The lens concentrates infrared rays, which are received and turned into a picture by a flat, supersensitive infrared detection element that the Lab developed by using ultralarge-scale integrated circuit (ULSI) technology.

When the bald head is turned, the distinct figures of Self Defense Force members drilling in a nearby lot are pictured on a black and white infrared image monitor. One can clearly see the tip of a cigarette being smoked by a member at ease turn white on the screen. When a helicopter flying in the distance is caught, the sensor automatically homes in on the helicopter's movements.

This infrared sensor technology is not found in the private sector. Although the resolution seems fine enough at the present time, "we would like to improve the detail so that it is at the level of high definition television" (Lab Chief Masutani). If the definition is improved, the precise shape of the target would be known, and targets far away could be caught.

2. Emphasis on "Soft" Fields

In addition to infrared sensors, the No. 2 Lab is engaged in developing radar and sensors that use the various types of electromagnetic waves, including ultraviolet, visible light, milliwaves, and radio waves, and is developing information processing systems that integrate the information from the radar and sensors to identify an enemy's true form. For example, if an image is processed by combining the reflected light from laser beams in the visible and infrared range, a tank hidden in a grove can be sharply delineated. Furthermore, the vibration characteristics of the tank engine can be identified from the subtle fluctuations in the frequency of the reflected light, so that the tank's classification can be known.

Along with this kind of detection system, the collection of navigation systems that find the location of opposing forces, computer systems that aid commanders by processing the vast amounts of information related to military operations, and communications systems comprise the C^3I system. This is a basic technology that all land, sea and air Self Defense Forces have in common, and if it is not secure, the frontal equipment such as tanks and fighter planes cannot be effectively utilized, no matter how superior. From this point on, with a little extra time to develop frontal equipment, "[TRDI] will place priority on researching "soft" fields such as C^3I and human interfaces" (TRDI Director Mahiro Ota).

Practical application of systems based on advanced information processing and communications technology is taking place in the private sector as well, but TRDI's C^3I, which is pivotal in electronic warfare technology, is very different from these. Crushing the enemy's C^3I functions is essential in modern warfare, and the C^3I system jams and confuses the opponent's sensor and communications systems, and intercepts communications. And should laser irradiation come from the enemy, it is vital that the opponent's sensors are confused by emitting a strong beam of one's own, and that interception of one's own communications be prevented. The private sector cannot concern itself with this kind of electronic warfare technology, as jamming and interception of radio navigation is forbidden to ordinary enterprises.

Providing For Peacekeeping Operations As Well

However, active engagement of the C^3I system based on specialized electronic warfare technologies is not necessarily for emergency use only. The system is also important in allowing Self Defense Forces to act promptly when rescuing victims of natural disasters or during recovery operations. "High function infrared sensors may be very influential in saving lives" (Lab Chief Masutani). There are also concerns that in the coming multimedia society, high tech crimes of information system abuse will occur, but electronic warfare technologies may be advantageous in protecting these systems.

The scope of activities of the Self Defense Forces is widening to include overseas expeditions with the United Nations peacekeeping operations (PKO) and Hanshin [Osaka-Kobe] earthquake disaster relief. Most of the PKO destinations differ from Japan in terms of climate and physical features, so the importance of equipment conversion must be considered. Until now, TRDI's level of priority for technological development related to PKO and rescue operations has been low, but TRDI Director Ota has indicated his intention to actively take on work in these fields. The range of defense technologies is broadening, and the roles that TRDI is being asked to fill are beginning to diversify.

This is a U.S. Government publication produced by the Foreign Broadcast Information Service (FBIS). Its contents in no way represent the policies, views, or attitudes of the U.S. Government.

FBIS collects, translates, disseminates, and analyzes foreign open-source information on behalf of the U.S. Government. Its publications may contain copyrighted material. ***Copying and dissemination is prohibited without permission of the copyright owners.***

— Bracketed indicators before the first sentence of each item describe the way in which the material was processed by FBIS.

— Headlines and all bracketed explanatory notes are supplied by FBIS.

— Personal and place names are rendered in accordance with the decisions of the U.S. Board on Geographic Names as adapted by FBIS. Unverified names in radio and television material appear in parentheses and are spelled phonetically; words and phrases in parentheses preceded by a question mark are unclear in the original and deduced from context.

SUBSCRIPTION INFORMATION

U.S. Government Customers

For a list of FBIS products, to subscribe to an FBIS publication, or to indicate a change of address contact:

FBIS
P.O. Box 2604
Washington, DC 20013-2604
Telephone: (202) 338-6735
FAX: (703) 733-6042

Non-Government Customers

Subscriptions are available from the National Technical Information Service:

NTIS
5285 Port Royal Road
Springfield, VA 22161
Telephone: (703) 487-4630
FAX: (703) 321-8547

New subscribers should expect a 30-day delay in receipt of the first issue.

END OF FICHE DATE FILMED

9 MAY 1995